THE

ELECTRICAL REVIEW.

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CONTENTS:

	PAGE
The "New Gas"	217
The Telephones and the Post Office	218
World's Fair Awards on Wire	220
Notes on a Synchronous Photograph	220
Electric Lighting of the Palais-Bourbon	221
The Recent Accidents Occasioned by High-Tension Currents	221
The Electro-chemical Relations of Carbon at High Temperatures (*concluded*)	223
Cost of Producing Electrical Energy	225
English Control of Submarine Cables	225
Transmission and Distribution of Electrical Energy	226
The Electro-deposition of Cadmium	227
The Douglas and Laxey Electric Tramway (*illustrated*)	228
Electric Lighting at Arundel Castle (*illustrated*)	233
Cheap Telegraphy	237
The British Association:—	
Hot *v.* Cold Walls for Steam Cylinders	237
The Hunting of Governed Engines	239
A Special Chronograph	240
On Standards of Low Electrical Resistance	240
Woodhouse & Rawson United, Limited	240
French Submarine Cables	241
Correspondence:—Electric Lighting Contracts and Professional Advice	241
Portable Batteries	242
Synchronous Photograph taken at Portsmouth	242
Electrical Distribution by Alternating Currents	242
Notes	242
Business Notices, &c.	245
Contracts Open and Closed	246
City Notes, &c.	246
Traffic Receipts	246
Share List of Electrical Companies	247
New Patents	248
Abstracts of Published Specifications	248

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THE "NEW GAS."

GREAT interest was awakened at the recent meeting of the British Association by a communication from Lord Rayleigh and Prof. Ramsay on a new gaseous substance which they claimed to have discovered in the atmosphere. They observed that if air is subjected to the action of electric sparks, the resulting nitrous fumes absorbed by potash and the excess of oxygen by alkaline pyrogallate, there remains a gaseous residuum which is neither oxygen nor nitrogen. The same residuum is obtained when nitrogen extracted from the air is exposed to the action of magnesium. It is characterised by extreme inertness; its density is 19·09, and it gives a spectrum with a blue line of much more intense colour than the corresponding line in the nitrogen spectrum.

The interest aroused in this communication was promptly translated by the daily Press into a "sensation." Lord Rayleigh and Prof. Ramsay were reported to have discovered a "new element," and much speculation was indulged in. And this in spite of the fact that they prudently adopted the word "gas" in describing the constituent which they claimed to have isolated from the atmosphere, and would not, for the present at least, commit themselves to the word "element." We should have expected this, for both Lord Rayleigh and Prof. Ramsay are distinguished Fellows of the Royal Society, and leaders in scientific research; we feel certain that they would be disposed to claim too little rather than too much. We are under a strong impression, however, that in this instance they have surrounded their "discovery" with more mystery, if not glamour, than the occasion warrants.

In connection with the statement of the existence of a new gas in the atmosphere, it is interesting to note the views of Cavendish on the subject, more than a century ago. In a paper on "Experiments on Air," read at the Royal Society, June 2nd, 1785, he stated that the diminution in the value of air on passing electric sparks "depends upon the conversion of phlogisticated air into nitrous acid." He pointed out (*Phil. Trans.*, 1785, p. 381) that a few negative properties were all that was known of the "phlogisticated" part of our atmosphere, and stated that it might fairly be doubted "whether there are not, in reality, many different substances confounded together by us under the name of phlogisticated air." He "therefore made an experiment to determine whether the whole of a given portion of the phlogisticated air of the atmosphere could be reduced to nitrous acid, or whether there was not a part of a different nature from the rest, which would refuse to undergo that change." He passed sparks through a volume of air, to which oxygen was added in excess, over an alkaline solution. "Having by these means condensed as much as I could of the phlogisticated air, I let up some solution of liver of sulphur to absorb the dephlogisticated air [oxygen]; after which only a small bubble of air remained unabsorbed, which certainly was not

more than $\frac{1}{120}$th of the bulk of the phlogisticated air let up into the tube; so that if there is any part of the phlogisticated air of our atmosphere which differs from the rest, and cannot be reduced to nitrous acid, we may safely conclude that it is not more than $\frac{1}{120}$th part of the whole." So much for the views of one of the old school of chemists, who apparently was unable to definitely distinguish the bubble of residual gas from nitrogen.

In reviewing the evidence of the existence of the "new gas," it is clear that great importance is attached by Lord Rayleigh and Prof. Ramsay to the difference which its spectrum exhibits as compared with that of ordinary nitrogen. The plurality of the spectra has been the subject of much discussion, and the rival theories have not yet been brought quite into accord. There are certain facts, however, and views based upon them, which appear to us to provide some explanation of the nature of this "new gas."

Plücker, Hittorf, and some others claimed to distinguish at least two spectra of nitrogen according as the electric discharge which made it luminous was of high or moderate tension. Ångström, however, emphatically stated that his observations convinced him that a gas when pure has only one spectrum, but that changes of temperature due to the kind of discharge used, would have the effect of causing more lines to become visible in the spectrum and of *increasing their relative brightness*, though the fundamental character of the spectrum would remain unaltered. Upon the death of Ångström, Thalén maintained these views and supported them with much experimental evidence. His observations further led him to the opinion that *if any apparent variety was displayed by the spark spectra of gases it was due to the effect of allotropic modification.*

Wüllner's investigations on nitrogen and other gases seem to indicate that the spectra exhibit slight modifications in appearance *according as the density of the gas varies*, and to the kind of electric discharge by which they are produced. Then there are Lockyer's experiments on the plurality of spectra which demonstrated that when a gas is examined under a moderate pressure, and not very high temperature, a simple spectrum of lines is obtained; and if the pressure is increased *one or more of the lines will become brighter and eventually broader.*

Did space permit we might quote Schuster, Goldstein, Crookes* and others; but it is clear from what has been said, and especially from what has been underlined, that light can be thrown upon the nature of this "new gas" merely by referring to well known previous investigations. Lord Rayleigh and Prof. Ramsay may have obtained an allotropic form of nitrogen, or have been examining this well known gas under conditions new to them. Taken, however, with the fact that the density of the gas is 19·09, which is admittedly too low (Prof. Dewar thinks its theoretical density should be 21), and with the fact that after nitrogen from the atmosphere had been exposed to the action of magnesium, there still remained a residuum which was more inert than nitrogen, since it would not combine with the magnesium, we are impelled to the conclusion that the first suggestion is the true one. In all probability all that has been isolated is an allotropic form of nitrogen.

Thus by reviewing the evidence in the light of previous investigations on the spectra of gases, we find ourselves brought to the same conclusion as Prof. Dewar, who, writing to the *Times*, August 18th, said:

> We have only to assume that when nitrogen enters into chemical combination with another substance, whether oxygen, as in the case of Lord Rayleigh's plan of working, or magnesium, as in that of Prof. Ramsay, a small portion of the gas is condensed molecularly into an allotropic form, having one and a half times its normal density. We are familiar with such action in the case of the transition of oxygen into ozone, and practically identical methods are being employed in the assumed separation of the new substance from air.

Prof. Dewar is able to support this view by reference to his own experiments with liquid air at the Royal Institution. He does not believe that allotropic nitrogen can be a normal constituent of the air. Were it produced in ever such small quantity—for example, by the passage of electric discharges—its very inertness would favour its accumulation, just as the high chemical activity of ozone tends to its dissipation; but in the course of ages the quantity of this nitrogen still remains inappreciable. The inference, in fact, is that the "new gas" which Lord Rayleigh and Prof. Ramsay claimed to have "discovered" to be a normal constituent of the atmosphere is being *manufactured* by them, and not separated from ordinary air, as they imagine. Honour, however, is due to them, for if this inference be correct, and they are really manufacturing allotropic nitrogen, they are succeeding in isolating a gas which many chemists and physicists have believed to be possible, but which has hitherto eluded every attempt to prepare it.

* It is rather disappointing to find that *The Chemical News and Journal of Physical Science*, of which Mr. Wm. Crookes, F.R.S., is the editor, entirely ignores the "new gas" in its issue for August 17th.

THE TELEPHONES AND THE POST OFFICE.

When the Postmaster-General was asked some time ago to lay upon the table of the House of Commons the agreement between the Government and the telephone companies he first declined, but eventually undertook to do so. In pursuance of that promise the agreement was ordered to be printed on the 7th inst., and was issued last week. As the session is drawing to a close, Mr. A. C. Morton maintained that it could not receive proper attention when "everybody was taking their holidays," and desired that its consideration should be postponed until next session. The Postmaster-General said that such postponement "would be to the inconvenience and prejudice of the public service," but, upon further pressure, on Thursday last week, the Chancellor of the Exchequer said the agreement would not be pressed this session if there was any strong and well-founded opposition to it. Mr. Benn stated that the feeling against the agreement was very strong (in the London County Council), and the Postmaster-General thereupon intimated that as he gathered that there was a general feeling that the ratification of the agreement should be postponed, he would, under the circumstances, assent to that course. Thus an

agreement which has been in preparation for two years is to be further delayed in its completion.

Although we are of opinion that the settlement of such matters as the agreement deals with would be far better arranged without the intervention of Parliament, we are obliged to admit that since the Government has consented to submit the agreement to the House, it may as well be presented when the time at disposal will permit the consideration to be thorough. The agreement, prosaic as it reads, is of considerable importance.

The licenses originally granted to the telephone companies limited exchanges to restricted areas, and did not permit inter-town communication. The inconvenience of this arrangement to the public and to the companies was brought before the Government of the day, and under Mr. Fawcett's direction the restrictions were removed in 1884, since which time a considerable business has been developed in what is known as trunk line messages. The agreement now awaiting ratification is practically the relinquishing by the Telephone Company of the Fawcett concessions, and the return to the original restricted-areas-license. The agreement defines the areas within which exchanges may be worked, and provides for the purchase and working of the trunk lines by the Post Office. The purchase price of the lines was originally arranged to be 10 per cent. over their cost; but as the cost price is not ascertainable from the company's books, it is to be 10 per cent. over the estimated cost ascertained by two experts in telegraphic engineering, one appointed by the Post Office and one by the company, subject to arbitration in event of disagreement. Unless an earlier day be mutually agreed upon, the Post Office will acquire possession on July 1st next of all trunk lines outside an exchange area. As it is obvious that within an exchange area a "route" of lines may contain both trunk and subscribers' wires, the agreement provides for the control of the lines by the owner of the majority, and the Post Office acquires those routes which contain a larger number of trunk wires than of subscribers' wires, unless the arbitrator shall be of opinion that the retention of the whole number should be essential to the conduct of the company's business. The maintenance of such joint routes is provided for by a clause which seems fair, at first sight, since the price specified applies to both sides; but if the figures arrived at are reasonable for average lines, the Post Office would seem to have the better bargain in this respect. As trunk lines are of heavier material than subscribers' lines, and maintenance includes renewals, the company will have to maintain the more expensive, and the Post Office the least expensive. Where such mixed routes exist, the comparatively large number of subscribers' lines over trunk lines would lead to the probability that in most of such cases the company would be the "predominant partner," and retain control of the route with its responsibilities or profits.

Where communication is effected over trunk lines between subscribers on exchanges of different ownership, the charge to be made by the exchange company is limited, but the charge to be made by the Post Office, if the Post Office should be the exchange authority, is not limited. Where the trunk wire charge is eighteenpence, the terminal charge is limited to threepence, for a three shilling trunk fourpence, and over three shillings a charge of sixpence may be made.

As the agreement provides for the establishment of facilities for telephoning telegraphic messages, express messages, &c., from exchange subscribers to post offices, and the establishment of call offices in post offices, provision has to be made for the settlement of accounts. A commission of 5 per cent. is allowed to the authority initiating the work and receiving the charges, of which settlement is to be made monthly, "but the Postmaster-General shall not be responsible for any such charges or sums as aforesaid which he is unable to collect." We do not observe a similar saving clause on behalf of the company.

The first ten clauses of the agreement are principally concerned in the arrangements to be entered into by reason of the company relinquishing its trunk line business. Clause 11 confers on the company powers to exercise the wayleave powers of the Postmaster-General, and clause 13 reduces the wayleave charge on railways to one shiling per mile per annum instead of twenty shillings as hitherto.

It will be seen that the agreement has few important changes over the scheme laid down in the Treasury minute upon which we commented at the time it was issued. The principal difference is in the conditions between then and now. So far as actual working goes, there are practically only two parties to consider, the Post Office and the National Telephone Company. The agreement, however, bristles with references to "other licensees," and the clause by which the Postmaster-General retains his right to work exchanges himself, or license others to work them, is very explicit.

It is not difficult to forecast the probable line of comment in the House of Commons, from the remarks of the members who urged postponement. The desirability of licensing municipalities will probably be strongly urged. The Government have already expressed their views on that head.

Municipal telephones is a very taking subject, especially to those who have more to do with local government than telephones, and it will probably require some firmness on the part of the Government to prevent any municipal inroads on their telegraphic monopoly.

Prof. Silvanus Thompson on Some Advantages of Alternate Currents.

In his recent paper before the British Association, on "Some Advantages of Alternate Currents," Prof. Thompson makes the statement "with them (alternate currents) there is far less likelihood of trouble from leaks in the distributing circuit than if continuous currents were used at the same voltage," and he argues that this must be the case "from the circumstance that the electrolytic action of the alternate current is so extremely small." We have here but one more instance of the fallibility of theory unsupported by practice. This is not the first time that we have had to point out the mistakes that electrical engineers have fallen into owing to an absence of the inestimable advantage which a long training in a submarine cable factory gives. If there is one fact that a lengthened experience in the manufacture of submarine cables teaches it is, that in order to "break down" a fault the application of rapidly alternating currents is one of the most effectual means to employ. We do not intend here to enquire into the why and wherefore of the fact, but that it is a fact is undeniable. Moreover, it is the very breakdown test employed by the experts on the Worlds Fair awards on wires, as may be seen on reference to page 220.

WORLD'S FAIR AWARDS ON WIRE.

Our American contemporaries have received from Prof. Anderson, secretary of the Judges on Electricity at the World's Fair, the subjoined list of awards made on insulated wires; to which are appended the awards for telephone cables and bare electrical wire. No data is ready yet as to the series of tests made.

W. R. Brixey. Address, New York, N.Y.

Group 126—Class 769.

Insulated Wire for Electric Light Service.

AWARD.

1st. Highest excellence in insulating qualities.
2nd. Durability of insulation under conditions found in commercial service.
3rd. Uniform high excellence in mechanical qualties of insulation.
Note.—This report is based upon the results of exhaustive tests approximating the various conditions to be met with in practice by insulated wires in electric light service.

D. C. Jackson, *Individual Judge.*

Henry S. Carhart,
President Departmental Committee.

Okonite Co. Address, New York, N.Y.

Group 126.—Class 769.

Insulated Wire.

AWARD.

(*a*) *Rubber Insulated Wires for Electric Lighting.*
1st. High excellence in insulating qualities.
2nd. Durability of insulation under conditions found in commercial service.
3rd. Uniform high excellence in mechanical qualities of insulation.
Note.—This report is based upon the results of exhaustive tests approximating the various conditions to be met with by insulated wires in electric light service.
(*b*) *Lead Covered Cable for Underground Electric Light Service.*
This cable has proved successful in commercial service.

D. C. Jackson.

Henry S. Carhart.

New York Insulated Wire Co. Address, New York, N.Y.

Group 126.—Class 769.

Grimshaw White Core Insulated Wire.

AWARD.

1st. Durability of insulation.
2nd. Mechanical excellence of insulation.
Note.—This report is based upon the results of exhaustive tests approximating the various conditions to be met with in practice by insulated wires in electric light service.

D. C. Jackson.

Henry S. Carhart.

Simplex Electric Co. Address, Boston, Mass.

Group 126.—Class 769.

Insulated Wires.

AWARD.

These are good weather-proof wires.

D. C. Jackson.

Henry S. Carhart.

Standard Underground Cable Co. Address, Pittsburgh, Pa.

Group 126.—Class 769.

Lead Covered Cables for Underground Electric Light and Power Service.

AWARD.

This cable has proven successful in commercial service.

D. C. Jackson.

Henry S. Carhart.

Norwich Insulated Wire Co. Address, New York, N.Y.

Group 126.—Class 769.

Lead Covered Cables for Underground Electric Light Service.

AWARD.

This cable has proven successful in commercial service.

D. C. Jackson.

Henry S. Carhart.

Department J, Electricity.

Only Award. 2,446.

W. R. Brixey. Address, New York, N.Y.

Group 133.—Class 790.

Exhibit.—Telegraph and Telephone Cables, Underground, Aerial and Submarine.

AWARD.

1st. Excellence of material and construction.
2nd. High insulation.
3rd. Reliability and durability demonstrated by records of prolonged service under exacting conditions.

M. O'Dea, *Individual Judge*

Approved: Henry S. Carhart,
President Departmental Committee.

J. A. Roebling's Sons Co. Address, Trenton, N.J.

Group 126.—Class 769

Exhibit.—Bare Copper and Trolley Wire.

AWARD.

1st. High conductivity.
2nd. Long lengths.
3rd. Great tensile strength.
4th. Uniform gauge.

M. O'Dea, *Individual Judge.*

Approved: Henry S. Carhart,
President Departmental Committee.

Washburn & Moen. Address, Worcester, Mass.

Group 126.—Class 769.

Exhibit.—Bare Copper Wire.

AWARD.

High conductivity.
This exhibit includes bare copper wire for lighting and power circuits, trolley wires, and hard drawn wire for telephone circuits.

B. F. Thomas, *Individual Judge.*

Approved: Henry S. Carhart,
President Departmental Committee.

In connection with the above awards, the following were the tests made during the World's Fair:—

1st Test.—Breakdown test, using Westinghouse 2,000-volt alternating current in connection with Westinghouse step-up transformer.

2nd Test.—Continnous high pressure—6,000 volts—wires run in ordinary water.

3rd or Soak Test.—1st. Solution 10 per cent. sulphuric acid. 2nd. Solution 10 per cent. ammonia. 3rd. Solution saturated lime. 4th. Solution subway refuse dissolved in Chicago hydrant water. 5th. Solution Chicago hydrant water.

Time of test, 100 days.

Ten varieties of wire were in the test. Wires were tested weekly by galvanometer, and the figures recorded for computing the results, and making the awards.

Wires Tested.—Kerite, Okonite, Grimshaw, Simplex, Safety; E. M. W. (General Electric) Paranite, Washburn and Moen Salamander, Washburn & Moen rubber covered, Roebling Crescent.

Prof. Jackson and the other members of the committee are now preparing an exhaustive report on their work, but the results have been given out in advance, along with awards to the successful competitors, as given above.

NOTES ON A SYNCHRONOUS PHOTOGRAPH.

By Rankin Kennedy.

The description of this photo in last week's issue may be supplemented by the following notes.

The important points to observe in the picture are the distinctness of the moving field coils which are almost as clearly photographed as if they were at rest, while the spokes of the wheel and the connecting rod are not shown at all; and secondly, the position of the field poles in relation to the armature coils. This position is not very clearly defined in the reproduction of the photo, but it could be for our purpose enlarged and made useful to show the actual lag of the current in the arc light behind the impressed E.M.F., and much important information thereby gained.

First, then, we may point out that the only differences between this photo and one taken by a continuous current arc light would be in the field coils. The field coils, with the alternating light falling on them, appear fixed, because these coils are always in the same position with regard to the armature coils at the instant of maximum current in the lamp. The alternating arc light is a series of flashes with

intervals of semi-darkness, and one coil has moved into the position of the next coil, during the interval, between the flashes; hence, they are illuminated always in the same places.

Some time ago, the writer, in working out a long series of experiments on photographic arc lamps for a manufacturing firm, noticed this effect, and on investigating the matter it was found that the sharpness of the image of the moving coil depends on the shape of the alternating current curve, a saw tooth curve giving the clearest image, for the simple reason that with such a curve the interval of semi-darkness is longer and the flashes of light more instantaneous. Most arc lamp currents are forced into a saw tooth curve by the choking effects in the coils and regulators, and a louder humming sound indicates this shape of curve.

If the photo is taken with a continuous light, the spokes of the fly-wheel would still be missing, and so also would the coils; they would show up only as a neutral grey band.

The other point is of interest to all students of alternators, as it shows us unmistakably the position of the field poles in relation to the armature coils at the moment of maximum current, actually measuring the lag between E.M.F. and current. Of course, certain precautions would require to be taken to get the exact measurement, but it would be a valuable observation, and lead directly to a method of observing the leads and lags in alternating motor armatures under varying excitement. If photos were thus taken at various exciting powers from a synchronising motor, the relative positions of the poles and coils could actually be seen; different loads and different excitements would give pictures showing different positions of the poles. A few photos would be very interesting, if taken from a part only of the poles, so that the pictures would be large and well defined, and with a white index line drawn in the position of maximum induction, the deviation of the poles under various loads and currents would be seen to correspond to the theory referred to by Prof. S. P. Thompson in his paper at the B.A. meeting.

Wheatstone's revolving mirror is used to examine the arc and shows it to be a series of flashes.

A mass of what at first sight appears to be new phenomena has been observed by those who, like myself, have been working with alternating currents during the past twelve years. Most of it, however, can be explained very simply, but as the ordinary experience of electrical engineers does not acquaint them very closely with alternating currents, these things are considered quite novel when they happen to be observed in actual practice.

ELECTRIC LIGHTING OF THE PALAIS-BOURBON.

The idea of substituting at the Palais-Bourbon the electric light for gas and oil is relatively old. In 1880 a first attempt was made in the Hall of Sessions by means of the arc light produced by a portable engine and a Gramme dynamo. The undertaking was conducted by the Jablochkoff Company. If the result was unsuccessful, we must remember that at that date the arc light yielded by candles (Jablochkoff candles) was the only one used, and it was wanting in steadiness.

Meanwhile, the invention of the incandescence light and the improvement of the arc light have simplified the problem and rendered electric lighting more practical and economical on the largest scale. Hence the idea of lighting the chamber electrically has been again taken up.

The lighting of the Palais-Bourbon and its appendages cost for the year 130,000 francs:—

	Francs.
Gas	103,000
Oil and candles	17,000
Cost of maintenance	10,000
	130,000

Taking gas at 0·30 francs per cubic metre this sum represents 400,000 cubic metres of gas. As a mean we may assume that a cubic metre of gas yields 8 carcel hours, whence the total lighting of the Palais-Bourbon represents a luminous intensity of 3,200,000 carcel hours.

If the electric light is entirely generated by incandescence lights an electric carcel requires 30 to 40 watts, or even more. The necessary quantity of electric energy (141,900 watt hours) expended in the form of current demands 192 effective H.P. But to provide against accidents the installation must have at command at least 250 H.P., capable of furnishing electricity to the extent of 141,900 watt hours.

The complete illumination of all the localities of the Palais-Bourbon would require:—

	Candles.
2,170 incandescence lamps at 10 candles	21,700
714 incandescence lamps at 16 candles	12,424
17 incandescence lamps at 32 candles	544
	33,668
And 30 arc lights at 1,200 candles ...	36,000
	69,668

To meet all possible demands in the future and to be prepared for every emergency there would be required an annual maximum consumption of 2,400,000 utilising 400 H.P.

The Cour Colbert from its central position is indicated as suitable for the machinery. The total cost of installation is estimated by the firms of Jean and Breguet at 500,000 francs.

The present intensity of illumination is calculated as 1,440,000 hecto-watts; that to be provided electrically will be 1,600,000 hecto-watts, or an increase of 11 per cent.

The present lighting costs 130,000 francs yearly. The annual outlay for the electric lighting will be 72,000 francs. —*L'Electricien.*

THE RECENT ACCIDENTS OCCASIONED BY HIGH-TENSION CURRENTS.

I recently drew attention, writes M. G. Claude in *L'Industrie Electrique*, to the danger to human life entailed by the intervention of capacity in the canalisations for high tension alternating currents. With the object of lessening the number or the gravity of the accidents resulting from this cause, I have proposed a very simple arrangement, based on the reciprocal actions of self-induction and capacity, and of which I hope soon to be in a position to give the practical results. The sad accident at Cannes has just furnished a fresh proof of these dangers, and has provided the opponents of the alternating currents with fresh arguments, which they have not failed to seize upon. For my part, I merely see in it one more demonstration—unfortunately too clear—of the importance of discovering a perfect solution of the problem that I have been studying.

I wish in this article to discuss, on rather a different plan to that ordinarily followed, this question of accidents occasioned by high tensions in general, both in the case of continuous and alternating currents. There is a great deal to be said, and perhaps to be done, with regard to this subject in many ways, and the study of precautions for the protection of human life is of sufficient importance for me to be excused if I dwell upon it.

Is it not, for instance, astonishing that up to the present time no regulations have been drawn up with the object of indicating the various measures to be adopted in the case of such accidents, measures which it is indispensable should be known, if life is to be saved. We are sufficiently accustomed to the interference of the Government in all our affairs, for official intervention in this matter, not to seem uncalled for; it would have the effect of preventing the negligence or indifference of those responsible, and would be less open to objections than restrictions imposed when concessions of electrical energy are granted.

We know—M. D'Arsonval's researches have irrefutably shown—that in most cases high tension currents act by paralysing the functions of the heart and lungs, so that a person that has received a shock from them may be compared to a person apparently dead from drowning. The same treatment should therefore be applied to him, and this consists chiefly in using methods calculated to restore respiration, amongst which the rhythmic tugging of the tongue, advised by Dr. Laborde, seems to have given the best results.

It might have been supposed that this similarity to the cases that are provided for by humane societies would have led someone to think of the placards posted up by these societies wherever there is any danger. This plan, by making public the knowledge necessary in these cases, has produced sufficientiy good results for us to admit that the best thing to do in parallel cases is to follow their example.

This has not, however, been done. Up to the present it has been left to those witnessing an accident to do what seems best under the circumstances, which is a most deplorable state of affairs; for however anxious they may be to render assistance, the necessary knowledge is apt to fail many persons at the very moment when they have most need of it.

It follows, then, that not only do those interested in this matter do nothing to provide for persons being restored to life after an accident of this kind; that not only must the death of the greater number of the victims of electricity be imputed to this absence of instructions, but also that those interested neglect to take the most elementary precautions for themselves.

With electricity, as in other cases, the *rôle* of rescuer is attended with a certain amount of danger, to obviate which certain rules should be followed and certain precautions taken; if the work of rescue is undertaken by an inexperienced person, or by one who has lost his presence of mind, it may be as dangerous for that person as if he threw himself into the water to serve another in danger of drowning.

I wish to call particular attention to this point, which has, perhaps, received too little notice up to the present. A recent accident, which will no doubt lay the foundation for more definite instructions with regard to this matter, will confirm what I have said. I will briefly relate the occurrence.

Two workmen, belonging to the Compagnie du Nord, were working in the neighbourhood of a very high tension main, when a chance contact was produced between one of the workmen and the cables belonging to this canalisation. He remained clinging to the cables, as is unfortunately the rule in such cases, and his companion went to his help and tried to free him; but, receiving a shock in his turn, he was thrown to the bottom of the ladder which he had mounted. This was, perhaps, fortunate for him, notwithstanding the fact that his leg was broken, for, without this fall, the asphyxia caused by the current would have done its work. As to the principal victim, who was treated by Messrs. Leblanc and Picon, who were, fortunately for him, witnesses of the accident, we know what a splendid confirmation of M. D'Arsonval's doctrines resulted from his treatment—a confirmation, moreover, that we cannot note without a certain degree of sadness, for it clearly shows that the greater number of the victims of shocks far less severe and far less prolonged might easily have been restored to life, but for the ignorance of those by whom they were surrounded.

I will also briefly refer to the accident that occurred a few months ago in the Rue Saint-Augustin at one of the substations of the Popp sector, and which resulted in the death of an electrician. The unfortunate man, through a train of circumstances that we have not space to enter into here, had fallen in such a manner that one of his feet was in contact with a battery of accumulators that were being charged by the high tension system, whilst his bleeding head rested on the ground in a pool of acidulated water. One of his fellow workmen drew him away, dead, without any accident to himself, but it was certainly quite by chance, as I shall presently show, that he did not receive a shock in his turn, and that there were not, as in the preceding accident, two victims instead of one.

As I have already remarked, there are in such cases certain precautions to be taken. It does not do to obey heedlessly the impulse that leads us to rush to the rescue of the person in danger; we should first reflect, or we may risk our own life without saving that of the victim. But reflection under such circumstances can hardly be expected from many people, or from many workmen, either, for, as a rule, the witnesses of these accidents are workmen; moreover, the fear of a danger to one's self that we do not at the moment fully realise may lead to a certain amount of hesitation, the consequences of which may be fatal.

All this is evident. I did not, however, wish to confine myself to mere assertions, and I therefore endeavoured to confirm my opinions, as far as possible, by experiment. Several men employed in electrical work have been asked suddenly and separately what they would do in case of an accident to help the person in danger. They were certainly more able to reflect calmly on what ought to be done in such a case than if an accident had really happened. Nevertheless they all hesitated, and this is not to be wondered at, for the question, which is a very simple one in the case where the accident is supposed to happen at the works, where we have everything at hand, cannot but be embarrassing when we assume that we have nothing in readiness. For instance, if the accident occurs at some point of the canalisation, or on the premises of a consumer; but if this hesitation is only natural, it is no less true that, under present conditions, it results almost certainly in the death of the victim.

What is still more serious, the replies given by several of the workmen that were questioned showed that if they really had witnessed an accident, they would have most probably taken steps that would have resulted in consequences fatal to themselves.

It seems, therefore, that total ignorance on this subject is the general rule; the accidents that have happened, of which those we have mentioned form only a small fraction, confirm far too conclusively what I have said, and we are therefore justified in urging that it would be doing really useful work to give those interested the advantage of instructions that they could commit to memory beforehand, showing what precautions should be observed, pointing out the danger of acting in such and such a manner. These might form the first part of placards—drawn up after the fashion of those of the Humane Societies—such as I have already suggested.

It should, for instance, be set forth that the first thing to be done when an accident occurs is, of course, to cut off that part of the canalisation where it takes place, whenever it is possible, *i.e.*, when there is an interrupter near at hand. But this will not very often be the case; it will more probably be necessary to detach the victim himself from that part of the circuit with which he is in contact, being held fast by the paralysis or drawing up of the muscles.

In this case we must remember that as in the case of a simple contact between one of the cables and the earth, the body of the person who has received the shock forms part of the high tension circuit; that he is subjected, even very near the earth, to potentials that might be dangerous. Under ordinary circumstances, in fact, we know that about half the total resistance of the body is localised in the skin at the part where it is in contact with the earth. We must therefore take care not to touch with bare hands the skin of the person to whom the accident has happened, for we should then receive a current which, although far weaker than that passing through the victim, might still lead to serious consequences. It must not be forgotten that even if we should not receive an appreciable shock at the moment of contact, the danger may be all the greater; if, through the efforts made to detach the body, or through its contraction, its contact with the earth should cease or become less perfect, we should find ourselves suddenly forming part of the circuit, and in great danger in our turn. This is, for instance, what might have happened in the accident in the Rue Saint Augustin. If the workman who ran to the assistance of his comrade, instead of first disengaging his feet from contact with the accumulators, had begun by raising his head, which might have seemed more urgent, considering the blood that was flowing from the wound, he would, in his turn, have been traversed by a current capable of killing him.

We should, therefore, not touch the victim without first protecting the hands with dry rags, or, better still, India-rubber gloves, which form the best safeguard. We might, with a similar object, be led to stand upon an India-rubber mat or on some insulating material; but even if the insulation is perfect, this method is not to be recommended; far from it, the danger incurred may be all the greater, from the fact that we believe ourselves in perfect safety. For instance, it may be necessary to detach the hands of the victim from a cable, or it might seem advisable to raise him from the ground so as to break the circuit, and under such conditions, *i.e.*, well insulated, one would not hesitate, in order to save time or to have more freedom of action, to use the bare hands, and it might happen that at the moment the circuit was broken one would be in such a position as to receive the current through the arms and lungs. One might also be led to believe—at least, so I found from the examination already mentioned—that if we touch only those parts of the body

covered by the clothing we shall run no risk. This, again, is a dangerous mistake; perspiration may make the clothes damp and render them good conductors, especially under the arm-pits, which would be the very part likely to be seized. With an alternating difference of potential of merely 200 volts, and an insulated subject communicating with one of the terminals of the transformer employed, we receive in most cases violent shocks if, when connected with the other terminal, we touch these parts of the body.

It is no less true, however, that the clothes folded into several thicknesses constitute a pretty good insulator, and one that is always available. Thus, one mode of procedure that might do some good, if an accident should occur where there are no appliances at hand, would be as follows: To take off some garment and make a thick pad with it. By means of this pad to seize the victim, and try to pull him away, after having first, if possible, raised him from the ground, so as to break the circuit and relax the contraction of the muscles. If this cannot be done, another pad should be made with clothes and interposed between the ground and that part of the body of the victim in contact with it. The passage of the current will thus be interrupted, and the necessary respite given for trying more efficacious methods. A more effective precaution still, for really everything depends on the hands being protected, would be to insist that all men employed on high tension circuits should be always provided with a pair of India-rubber gloves.

It will be observed that in all the foregoing remarks I have assumed that the accident occurs between the cable and the earth, which is generally the case. These considerations could very easily be modified to suit the case of a simultaneous contact with both poles.

In short, then, the precautions to be taken under these circumstances are most simple. They would suggest themselves with very little reflection, and it will perhaps seem somewhat unnecessary to repeat them, and to devote some pages to arriving at the conclusion that we must not touch with bare hands, a person who is suffering from a shock from a high tension current. But I feel that I cannot too strongly urge the importance of these points; in the first place those interested—workmen and others—are not always capable of even very simple reasoning; moreover, we cannot be surprised if even those who are capable of reasoning should, under such circumstances, lose their presence of mind.

Then the precautions to be observed for preventing as far as possible such serious accidents are so simple that it would be a thousand pities that there should be a moment's hesitation.

We are informed, morever, that at the request of M. Monmerqué, engineer to the City of Paris, in charge of the Halles Station, the Academy of Medicine, through M. D'Arsonval, will soon fill up the void to which I referred at the commencement of this article with regard to the treatment of people who have received shocks.

The profound experience that the eminent professor possesses with regard to these delicate questions is a sufficient guarantee of the manner in which this instruction will be imparted. If it is confined at first to the high tension systems at Paris, I sincerely trust that it will be sufficiently complete to take into account the dangers that I have described, and the means of avoiding them.

THE ELECTRO-CHEMICAL RELATIONS OF CARBON AT HIGH TEMPERATURES.

By E. E. BROOKS.

(*Concluded from page* 191.)

With regard to the fact that both the carbon and the sulphide were attacked, it may be worth while to point out that it is not an essential condition that one of the plates in a voltaic arrangement should be unacted upon, for both may be active provided that no opposing E.M.F. is set up. This means that the ion liberated upon the negative plate must combine with it instead of coming off in a free state; and, in fact, it is the ordinary working condition of a secondary battery. In the carbonate experiments, the E.M.F. was probably chiefly due to the action upon the CuS, as very little result could be expected from the CO combination.

It was evidently desirable to have some means of finding rapidly and fairly accurately the internal resistances, in order, also, to obtain the true electromotive forces, which with very high internal resistances might differ considerably from the voltmeter reading. The following plan was ultimately adopted and found very convenient in practice. A voltmeter was specially made and carefully calibrated, reading up to 2 volts and to ·025 volt, and a 2 ohm resistance was arranged so that it could be put in parallel with the voltmeter when required. The voltmeter resistance was 36·7 ohms. By taking one reading without the two ohms, and another with it in parallel, the internal resistance and true E.M.F. could be found by a simple calculation, for if

e = reading with voltmeter alone,
e_1 = reading with 2 ohms in parallel,
r = voltmeter resistance,
r_1 = combined resistance of voltmeter and 2 ohms in parallel,
b = battery resistance,
E = true E.M.F.,

we have $b = \frac{r\,r_1\,(e - e_1)}{e_1\,r - e\,r_1}$, and $\mathrm{E} = \frac{e\,e_1\,(r - r_1)}{e_1\,r - e\,r_1}$,

the denominator being the same in each case. The readings were taken at intervals, and the values calculated afterwards. The proof of the above result is as follows. Let c = current in first case, and c_1 = current in second case.

Then $e = c\,r$, and $c = \frac{\mathrm{E} - e}{b} = \frac{\mathrm{E}}{b + r}$

also $e_1 = c_1 r_1$, and $c_1 = \frac{\mathrm{E} - e_1}{b} = \frac{\mathrm{E}}{b + r_1}$

$$\therefore\ e = \frac{r\,(\mathrm{E} - e)}{b}$$

$$e_1 = \frac{r_1\,(\mathrm{E} - e_1)}{b}$$

$$\frac{e}{e_1} = \frac{r\,(\mathrm{E} - e)}{r_1\,(\mathrm{E} - e_1)}$$

$$\mathrm{E}\,(e_1\,r - e\,r_1) = e\,e_1\,(r - r_1)$$

$$\mathrm{E} = \frac{e\,e_1\,(r - r_1)}{e_1\,r - e\,r_1}$$

Taking the other values of c, we have:—

$$\frac{e}{e_1} = \frac{r\,(b + r_1)}{r_1\,(b + r)}$$

$$b\,(e_1\,r - e\,r_1) = r\,r_1\,(e - e_1)$$

$$b = \frac{r\,r_1\,(e - e_1)}{e_1\,r - e\,r_1}$$

It is unnecessary to mention the various salts tried, with unsatisfactory results. Nothing of importance was met with until I tried the acid potassic sulphate, $KHSO_4$. This salt fuses at a low temperature, gives off the elements of water, and becomes K_2SO_4, SO_3, ultimately being converted by prolonged ignition into the normal sulphate. Rods of carbon and CuS were placed in a crucible and this salt added, an E.M.F. of ·3 volt being immediately obtained, but instead of the CuS being negative, as in the previous experiments, it was positive, and acted as the zinc of an ordinary battery. A slight flame, as of burning sulphur, played above the crucible, and SO_2 gas was given off. On substituting a nickel wire for the CuS, ·7 volt was obtained, the nickel being also positive. As the ebullition of the salt decreased these readings gradually diminished, and after a considerable time, the salt having become semi-solid, there was a reversal of E.M.F., and I obtained a reading of 1·05 volt between carbon and CuS, both in the salt, the carbon being now positive. Normal potassic sulphate being quite infusible in an open fire, the result of ignition was always to leave a solid residue, and hence a gradually increasing internal resistance.

In a subsequent experiment two carbon rods were used instead of one CuS and one carbon. One of the rods was placed in the crucible and the other in the fire, and $KHSO_4$

crystals added. The carbon in fire was positive to the carbon in crucible, and hence the fire acted as a zinc. The reading was at first about ·2 volt, and this steadily increased until it reached 1·3 volts, when the salt had become semi-solid, the internal resistance being 7 ohms, and the true E.M.F. about 1·43 volts. When the fire connection was removed, and a Cu S rod placed in the crucible along with the carbon, the E.M.F. reversed, the carbon rod which had hitherto been negative to the fire becoming positive to the Cu S, as in the former experiment. This seemed to indicate that a still greater E.M.F. would be obtained between the fire and a Cu S rod in the crucible; but, practically, the result was about equal to that obtained with the two carbon rods. The arrangement was then left for about an hour, with one carbon rod in crucible and another in the fire, and on returning it was found that the reading had fallen to ·45 volt, the fire having also gone down a little, and the contents of the crucible had become quite solid. Throwing in a few crystals of $K H S O_4$ almost instantly brought the reading up to 1·3 volts, while adding sodic carbonate lowered it equally rapidly to about ·3 volt.

As the $K H S O_4$ ultimately becomes $K_2 S O_4$, I repeated the experiment with a mixture of $Na_2 S O_4$, and $K_2 S O_4$. As the fusion required a rather high temperature, a forge was used. A reading of about ·4 volt was obtained between carbon and Cu S, both in the crucible, and about as much between two carbons, one in the fire, and one in the crucible; but in the latter case the E.M.F. was in the opposite direction to that previously obtained, the carbon in crucible being rapidly attacked and acting as the zinc.

I then placed in the forge a crucible previously used with $K H S O_4$ in an open fire, and which contained a carbon rod imbedded in the solid residue. I also added other $K H S O_4$ residues from previous experiments, moderately ignited. A carbon rod was placed in the fire, and the reading steadily increased until it reached 1·52 volts for a short time. The temperature was kept rather low, and was probably hardly greater than that hitherto used. The reading remained about 1·35 volts for some time, the internal resistance being found to be 14 ohms, and the true E.M.F. 1·87 volt, while the contents of crucible were nearly solid.

The temperature was then steadily raised until fusion occurred. The result was that the reading fell to ·17 volt, the fall being especially marked just previous to fusion. Rods of Cu S and carbon placed in the fused salt behaved as before, the carbon being positive. Cooling having occurred, and the two carbons being replaced, one in fire and one in crucible, the addition of a little fresh $K H S O_4$ at once gave ·9 volt, and the reading soon remained steady again at a little more than 1 volt. I then added some calcic sulphate, and again raised the temperature until fusion took place, the reading falling as before, until it became zero at the fusing point. These results clearly show that the E.M.F. depends upon a difference of temperature between the carbon in crucible and the fire, and also that the normal sulphate is not the active material.

An attempt was now made to obtain a somewhat lower internal resistance, an ordinary porous pot, 4 inches × $1\frac{3}{4}$ inch, being used in place of a crucible, and four carbon rods connected together being placed within it, one rod outside making connection with the fire. About 2 inches were immersed in the salt. The voltmeter reading touched 1·5 volts for a few moments, but usually remained at about 1·2 volts, which meant 3 ohms resistance, and an E.M.F. of 1·57 volts. This arrangement rang an electric bell well, but the experiment soon ended by the breakage of the pot and the escape of its contents into the fire. A crucible of the same size as previously used was then put in place of it, the same rods being used, only rather more salt being employed than usual. This rang the bell almost equally well, the internal resistance being 4 ohms. In these and subsequent experiments nothing resembling polarisation could be detected, and if present at all, it was at any rate very slight.

As the salt $K_2 S O_4$, $S O_3$, or as it may be written, $K_2 S_2 O_7$, can be produced by gently heating normal sulphate with sulphuric acid, I tried the effect of adding a few drops of $H_2 S O_4$ to some well burnt residues. The reading was at first ·15 volt, but a few drops of acid raised it quickly to 1·1 volt. Too much acid lowered the reading for a short time. In this way, by adding a few drops of acid once or twice, a bell was kept continuously ringing for 40 minutes (the crucible being placed in the open fire of the laboratory), and might have been kept ringing for an indefinite period. In such a fire the internal resistance is always greater than in a forge, on account of the coals only touching the crucible in a few places.

Experiments were also made with sodium sulphate (Glauber's salt), and by first igniting it in the crucible until the water of crystallisation was driven off, and then adding a little sulphuric acid, an E.M.F. of 1·6 volts was obtained, with an internal resistance of 5·8 ohms. It was found considerably more troublesome to prepare the material in this way, and too much acid lowered the E.M.F. until the excess was driven off, but the final result seemed almost equally satisfactory.

There seems no doubt that the electrolyte in these cells is the salt, $K_2 S_2 O_7$, which of course comes into contact with the fire by percolation through the walls of the crucible. The way in which it splits up is uncertain, and requires further examination. It will be noticed that sulphuric acid is really the oxidising substance, the $K_2 S_2 O_7$ serving as a carrier between the acid and the carbon. The internal resistance depends upon the porosity of the vessel used, and so far nothing has been found to give better results than small Hessian fireclay crucibles, the larger sizes not being equally suitable. Some closer grained crucibles of Lambeth make gave an internal resistance of more than 40 ohms. When I am at liberty to continue the investigation I hope to use vessels made specially for the purpose. Meanwhile I think I have shown how to construct a really efficient carbon cell, which is a distinct advance on any previous attempts in this direction. The materials used in its construction are of the most inexpensive character, metals being entirely eliminated, while the fact that it is possible to use burning coke as the positive element in a voltaic cell seems of special interest and importance, for it means that the carbon is used at a high temperature, and hence in its most positive condition.

Magnetism in Iron and Steel.—The results of heat treatment on manganese steel, and their bearing on carbon steel, formed the subject of a lengthy paper which was contributed to the *Proceedings* of the Iron and Steel Institute by Mr. R. A. Hadfield some few weeks ago. The paper starts by calling in question the validity of the "β-iron theory" in explaining the points of recalescence and the disappearance of magnetism in iron and steel. Mr. Hadfield's experiments lead him to believe that the disappearance of magnetism in manganese is due, at least to a very considerable extent, to a particular kind of carbide of manganese, or carbides of manganese and iron, the properties of which vary according to the thermal treatment. Considering the large amount of iron present in these steels, it might be imagined that this non-magnetisability was not permanent; and the experiments described in the paper show that this is to some extent correct. The β- or hard form of iron explanation is hardly possible, for it is found that the same material in each case, possessing practically the same composition, can be made to become magnetic or non-magnetic at will. The inconsistency pointed out by Wingham, in the β-iron theory, namely, that the permanent magnetism of hard steel, which is supposed to consist of β-iron, was not compatible with the non-magnetisability of manganese steel, which also is supposed to contain β-iron, has not been satisfactorily explained. Hardness seems to be quite independent of magnetic characteristics, as very hard carbon steel is magnetic, whilst hard manganese steel is not magnetic, although the latter can now have this property conferred upon it to some degree. If the presence or absence of these properties can be shown to be independent of hardness, it can hardly be possible to claim that manganese steel is proof of the existence of a non-magnetic β- or hard iron. Further, if β-iron can be made magnetic or non-magnetic at will, and of practically the same hardness in each condition, it will be inconsistent to say that the non-magnetic state of iron heated above 740° C. is due to the existence of atoms of β- or hard iron retained in that form when cooled down. Such is the line of argument. The researches of Roberts-Austen, Müller, and others are then reviewed, and Mr. Hadfield describes his own investigations with full detail. For these we must refer the reader to the *Transactions* of the Iron and Steel Institute.

COST OF PRODUCING ELECTRICAL ENERGY.

Our contemporary the *Electrical World* of New York publishes an article on the above subject by Mr. B. J. Arnold, or rather an abstract of Mr. Arnold's paper, read before the N.W. Electrical Association, St. Paul, Minn.

The author's estimate of the loss between I.H.P. and E.H.P. in a fairly well designed high speed belted direct current station are as follows :—

Engines 10 per cent., belts 4 per cent., dynamos 10 per cent., line 10 per cent., leaving 70 per cent. commercial efficiency. In alternate current the same losses occur up to the line. The primary circuit loss is given at 5 per cent.; the average transformer loss where there are many transformers, and many of them being underloaded, will reach 10 per cent., though at full load they would give an efficiency of 93 or even 95 per cent.

Secondary wiring is responsible for two per cent. loss, bringing down the efficiency of alternating plant to 65 per cent. Where a countershaft is interposed the net efficiency will be brought down to 58 and 52 per cent. respectively. This seems certainly a by no means too high an estimate, and agrees probably very closely with observed results on this side. A table is reproduced from *L'Industrie Electrique*,* by M. Laffargue, as the best information Mr. Arnold can secure of foreign stations, two, viz., Elberfeld and Hamburg being direct current plants; one, Cologne, being alternating; and three, Barmen, Hanover and Dusseldorf having accumulators added.

Cologne produces 71 watt hours per pound of coal, and delivers a kw. for 6·65 cents. Hanover produces 219 watts per pound coal and delivers a kw. for 5·2 cents; while Dusseldorf produces 185 watts and delivers one kw. for 4·54 cents, showing evidently an advantage in using accumulators, the commercial efficiency of which, it is noted, is 76·1 per cent.

Curiously enough there is a loss of over 30 per cent. between station and consumer at Dusseldorf; 20 at Hanover; 15 at Barmen; while at Hamburg and Elberfeld only 5½ and 2½ is lost.

For American stations Mr. Arnold finds 81½ watt hours per pound of fuel in 15 of the largest stations, varying from a minimum of 48 to a maximum of 122, the mean being simply the average of the watt hours column, not the true average of the total coal divided into the watt hours. In 10 other, but small direct current stations, the average is 66. In seven alternate current stations it is 95·3, and in three combined systems 141. As, however, there is no information as to the steam power, the final turnout per pound of coal is only a very rough method of ascertaining efficiencies. However, the total cost per kw. hour delivered averages 6·20 cents; made up of the costs of the fifteen stations which vary from 4·71 to 8·88, the turnover varying from 33,400 watt hours per day to over 600,000, but there is no perceptible ratio between cost and turnover, either direct or inverse, nor is there any such ratio in the six German plants quoted.

Mr. Arnold has tested a combined railroad and light plant and gives interesting figures. Thus, from 7.20 a.m. to 4.10 p.m., when the railroad is being operated, the cost averages 3·1 cents, but from 12 midnight to 5 a.m. it is 3·96, while from 5 p.m. to midnight, when the combined load is on, the cost falls to 1·75, or to only 1½ cents if the labour charge is deducted.

Thus it may be shown that 681 additional watt-hours, or over 90 I.H.P., could have been furnished from 6 a.m. to 6 p.m. for $9 of coal, or 1 cent per horse-power hour, showing a handsome profit on the selling price of 2 cents that can be obtained for motor work. Machines rated at a certain capacity do not actually work more than 45 per cent. of their nominal time, and, with a number of various machines being run, the above figures point to the capacity of 160 H.P. being furnished with motive power for what amounts to a mere trifle beyond the net fuel cost. Mr. Arnold suggests that an electric station might be combined with an ice-producing plant; about 2 H.P. will produce a ton of ice in 24 hours.

On this basis the electrical plant in question would furnish 20 tons of ice per day, and this at $3 per ton would produce a net extra revenue of $40 daily, say £8, from a plant of a total capacity of 392 kw. Per one ton each 24 hours, ice plants cost $2,700, the cost decreasing to $800 per ton for a 40-ton plant.

Though the necessity for ice is a very much smaller factor in our own climate than in the extreme heat of America, there should still be an opening for the suggested combination even in England. If not actually in ice production, something might be done in the way of cold air production—a possibility for Deptford.

Mr. Arnold looks to better economics from the use of better boilers, of fewer, larger and direct-coupled units and of accumulators, an adjunct Americans have, he says, been slow to appreciate, but which they are now inclined to value. He looks for a cost, in plants of not over 1,500 kw. capacity, of 5 cents per kilo-watt hour, with coal at $2.50 per ton and of 3½ cents in larger stations that can buy fuel cheaper. This excludes interest and profit but includes all expenses and depreciation.

The multiplication of lighting stations, railway power houses, hydraulic power houses, pumping stations, and other large installations, each with their own boilers, engines and buildings, is but one evidence of that persistent individualism in all we do, any attempt at the modification of which is howled down as socialistic and dangerous, though wherein comes the error of abolishing half the steam boilers in the country we do not ourselves see.

* See also Electrical Review for April 20th, page 445.

ENGLISH CONTROL OF SUBMARINE CABLES.

The war in Korea has again brought into prominence the entire control which England has over the submarine cable system of the world. French journalists complain that all their information is filtered through England, and that the English newspapers are always 24 hours ahead of them in news. A comparison of the means of communication with different parts of the world which the two countries possess is very interesting. The English companies own a network of submarine cables having a length of more than 150,000 miles, which were laid at a cost of over £30,000,000, and produce a revenue of more than £4,000,000. The English Government has done everything in its power to facilitate the laying of these cables, both by subvention and patronage, and, in fact, the preliminary surveys have been nearly all carried out by the naval authorities. In return, the three following clauses are inserted in the articles of association of the companies:—1. The despatches of the Imperial and Colonial Governments shall always have priority over all others when required. 2. No foreigner shall be employed by the companies, nor shall any wire pass into the offices or be under the control of any foreign Government. 3. In case of war the servants of the companies shall be replaced by Government officials when required.

France, on the other hand, has but one cable communicating directly with America, against the 10 of England. Such is the favour with which the English lines are regarded on the Continent, that nine out of ten Spanish communications with America pass over their lines, though it costs 4d. a word less to send them *viâ* Brest. At different times the French Government have subsidised with large amounts English companies for communication with Senegal, Saigon, Tonkin, for a line from Sierra Leone and Bathurst to French Guinea and Gabon, and also from Perim to Oback. It is not necessary to point out that France thus depends entirely on England for the means of communication with even her own colonies; and while we have every reason to be satisfied with the arrangement, we cannot help wondering at the short-sighted policy of the French Government, which has invariably nipped in the bud any project for laying cables of their own.

The above from the *Pall Mall Gazette* of 16th inst., together with the letter in the *Morning Post* of the same date, will certainly tend to create dissatisfaction in the minds of French authorities, if such a feeling has not already existed. Possibly this was the purport of the writer (or writers) of these communications, with a view to inspiring the French authorities to institute cable systems of their own, entirely independent of England or English companies.

We believe there is some ground for complaint, and we agree with the *Pall Mall Gazette* in wondering that the French Government have not realised sooner the weak position they are in, telegraphically speaking, in the event of war, as compared with England.

The letter in the *Morning Post* seems to be written by someone well acquainted with the facts of the case, and possibly he has in mind the lawsuit, instituted by our Government, which occurred *a propos* of improper usage of telegraphic news during the Egyptian war.

There are several points in the *Pall Mall Gazette* article

which call for comment. To wit, "the English Government has done everything in its power to facilitate the laying of these cables, both by subvention and patronage, and, in fact, the preliminary surveys have been nearly all carried out by the naval authorities."

We are of opinion, on the contrary, that our Government have been peculiarly backward in giving the necessary encouragement to cable enterprise, and, considering the circumstances, they have exhibited—proportionally speaking, at any rate—considerably less enthusiasm, and offered much less help, than the French, or, indeed the Spanish Government, in subsidies, and so forth. The only cause for surprise is, that the French Government, realising, as they have done, the importance of telegraphic communication, have not, whilst subsidising English cables, made more favourable terms for themselves, especially in view of possible warfare.

As for the last suggestion, it is simply ludicrous, for by their own showing any soundings or surveys that have been taken by the Government have been in the ordinary course for their own purposes in connection with the Hydrographic Department of the Admiralty. The recent soundings made by H.M.S. *Egeria*, in the Pacific, is a notable instance of this, especially as these soundings are not recognised as being of any practical account with a view to a Pacific cable—at least we judge so by the manner in which the Ottawa Conference appears to ignore them in this connection.

We believe there is no single instance of a cable which has not required as complete a preliminary survey over the proposed route by the company engaged to lay it, as if no soundings whatever had been previously taken by the Admiralty or otherwise. We venture to think that if the Pacific cable is ever laid it will be owing to zeal at the hands of the Colonial Government and Colonial merchants, rather than to any material encouragement from the home authorities.

We cannot agree, either, with the sentence in the *Pall Mall Gazette* article, which says:—"Such is the favour with which the English lines are regarded on the Continent, that nine out of ten Spanish communications with America pass over their lines, though it costs 4d. a word less to send them *viâ* Brest." Surely the explanation is that the telegraph service of English companies, and of our Government, is found more efficient in one way or another?

We are to some extent with the writer in his surprise at only one Atlantic cable communicating direct with France from America; but this is, presumably, partially to be accounted for by the fact of the small amount of trade done with France, as against that done with England, by America.

TRANSMISSION AND DISTRIBUTION OF ELECTRICAL ENERGY.

We have always held the opinion that the hostile attitude assumed by some engineers towards the introduction of the alternating system some years ago was a most unfortunate thing both for those who supported the policy and for the business of electrical engineering in general.

The introduction of a new method, system, or appliance, may temporarily injure the prospects of the older and established practices, but invariably an increase in the total amount of business done very speedily ensues. Every fresh departure or real improvement hastens the growth of a new business, and it would therefore seem imperative that engineers, especially manufacturing engineers, should heartily welcome and encourage anything new, or differing essentially from present practices, if for no other reason than that they tend to extend the trade. Unless the new proposals are of the fraudulent or "wild-cat" order, they, at any rate, do no harm. We had a notion that such views had been very generally accepted, and that the day when electrical engineers would publicly disparage a great line of electrical engineering progress was past. But, to our astonishment and regret, we find the old attitude struck by a well-known engineer at the B.A. meeting on the discussion upon Prof. Thompson's able paper "The Advantages of the Alternating Current." The Oxford system advocated by this engineer may be, and we believe is, a very good one, and in electrical engineering it will always find a place, but, like all other systems, it is not universally applicable; we must have different methods to meet various cases. It is fanatical conduct at this date on the part of any engineer to pin his faith to one method or system, and condemn all others, although it may be good policy to make a speciality of one line of business; but damning every other in the same trade can only result in disaster.

The onward and triumphant march of the alternating system, despite the hostile position assumed by those who ought to have been its best friends, has compelled every manufacturing firm to produce machinery for both continuous and alternating current electric lighting plants. Thus anyone may plainly see that had it not been for the increase of trade, due to the introduction of the newer system, every firm would be engaged in building similar plants, with nothing to recommend the one over the other, but resulting in fierce competition; and many places now enjoying the advantages of an electricity supply would have remained without it.

We are gratified to find in Prof. Thompson an advocate not only of alternating current working generally, but particularly polyphase methods; in fact, his clearly-expressed and favourable views entirely coincide with those we have so often expounded on the same subject. The polyphase system is highly praised by those who know it best, and although it has not yet, in this country, met with the same open hostility through which the single-phase method successfully passed, it has been treated even more shabbily by indifference, a sort of passive resistance even more deadly than active war. Now, from the business point of view, it must be obviously bad policy again, to sit upon a new system, the introduction of which would add to the number of machines to be manufactured, for it is a system which would meet cases not covered by any of the others, so that it would be adopted in places where none of the others could, at present, come in with so many advantages.

In other countries, polyphase machinery has already become a catalogued part of every manufacturer's trade.

It has been said that in the early days the manufacturers wanted capital more than engineers; now they have got both capital and engineers, they want trade; the only way to secure this is to adopt new departures. Even such an unpromising field as that opened in electrical heating and cooking has proved a success, in so far as adding new manufactures to the electrical engineer's business. What would be said of the engineer, unless he pinned his faith to gas, who publicly came forward and denounced it as wasteful, costly, uneconomical, unnecessary, and so on? It is very easy to set up a case like this and demolish it utterly. Yet the fact remains, that electrical heating is gradually and surely forging ahead.

There are, of course, fanatics on both sides of the distribution and transmission controversy; men who have one system, one plant, and in which alone they hold there are any good features. They would put it down anywhere and everywhere, regardless of circumstances. Such illogical beings are, however, becoming scarcer, happily for the prosperity of the electrical trades.

We have not far to seek for cases where the alternating system would have been better than the continuous, and *vice versâ;* these examples are valuable, for out of them has come the experience to guide future practice in deciding upon a scheme suitable for any case. On this point we may sound a note of warning against the adoption of advice from any man who, in all cases, in season and out of season, advocates one method. In the present state of the art of electrical transmission and distribution, no level-headed, unbiased engineer, would pin himself to the dogma that one system is sufficient to meet every case.

In many instances now arising in connection with municipal plants, the district to be supplied is compact and narrow, no transmission to a distance being necessary; it is a case only of distribution, and as high pressure distribution has now been abandoned, all distribution mains are run from sub-stations or central stations, instead of, as on the obsolete high pressure distribution system, being taken from each consumer's own transformer.

Now in cases like this, with the central station in the district to be fed, there is not much in favour of high pressure being used at all. As we have to run low pressure mains all over the district, there can be little advantage in

using high pressure, for the copper saved in the few short transmission mains which would be put in would be insignificant.

But, granted that in many cases now before municipal bodies, high pressure is not necessary on account of the nature of the scheme and the now universal adoption of a network of low pressure mains for distribution, that does not settle the question whether the supply is to be continuous or alternating. Not by any means, for even on a low pressure three-wire system alternating currents would in many cases show to vast advantage, not the least part of it being the facility which at any time or place a high pressure may be got, if wanted, within the district.

The battle of high pressure *versus* low pressure has recently assumed a new phase, to which we wish to attract attention, by the question as to how much is saved in an ordinary city or town plant by using high pressure for the few feeders and a mass of low pressure distributors in a limited compact district? The whole saving effected by high pressure is now reduced to that of the copper; not in all the mains, but only on feeders. To how much does that amount? We know it in some cases to be very small, so this view of the question is well worth discussion.

Only in great schemes of transmission to a distance, such as the Deptford system, is the adoption of high pressure a self-evident saving. To settle the point, high *versus* low pressure, we consider only the amount and distance of the transmission of the power or energy.

To decide upon the other and more important question as to the current to adopt is a more complicated matter, but one which is becoming clearer every day, and which will be much simplified by such discourses as that of Prof. S. P. Thompson. The discovery of the wonderfully simple method of regulating the supply pressure on alternating mains by a synchronising over-excited motor is one destined to still further recommend that system.

The more we consider the various advantages and drawbacks of the different plans, the more apparent it becomes that many plants are established without serious reflection; one place merely follows the lead of another, or falls into the hands of the same one-system class of engineer.

The objection raised against the alternating system on the score that storage batteries cannot be used, has no real foundation in fact, for if storage batteries were of such importance as to make their use a necessity, and if their employment would improve the economy, there are several simple and well known methods whereby they can be used with alternating systems, both single-phase and multiphase.

What amount of service is rendered by storage batteries used in continuous current stations is an unknown quantity. We know, from Mr. Crompton's tables, that they figure largely on the expenditure side of the accounts; but just what they do in return is apparently not so readily found out. Storage is very desirable on any system, so that if batteries as at present made can be shown to be doing work profitably, the makers and users would both gain by clearing up the doubts so often expressed regarding their value.

THE ELECTRO-DEPOSITION OF CADMIUM.

Smee appears to have been one of the first—if not the first—to deposit cadmium. Since he published the results of his experiments the matter has received little attention, partly due, no doubt, to the scarcity and considerable cost of the metal; it can now be obtained of good quality at a low rate. Its use has hitherto been confined to the production of the yellow sulphide, Cds, as an artist's pigment, and to the aid of the photographer in the form of iodide, Cd I_2, and bromide, Cd Br_2. Cadmium melts at the same temperature as tin, an alloy of 3 parts cadmium, 15 bismuth, 8 lead, 4 tin, fuses at the remarkable temperature of 140° F., 72° below the boiling point of water, which has led to its being selected for the manufacture of fusible alloys for electric cut-outs. A cadmium-amalgam, consisting of 78·26 parts mercury and 21·74 parts cadmium, agreeing with the formula, Hg_2 Cd, can be kneaded like wax at a moderate temperature, and was formerly used by dentists for stopping teeth. Cadmium resembles tin in colour and appearance, and is very malleable and ductile at the ordinary temperature. The comparative hardness of cadmium to other plated metals is shown in the following table:—

	Hardness.
Nickel electro plate	10·0
Sheffield plate	10·0
Antimony electro plate	9·0
Palladium (deposited bright)	8·0
Platinum electro plate	6·0
Cadmium silver alloy (Cd 60·5, Ag 39·5)	5·0
Cadmium (deposited bright)	4·5
Silver (burnished)	4·0

The figures represent the hardness as registered by the number of grammes weight on a diamond point required to produce a scratch.

Smee obtained good tough deposits of cadmium from an ammonia-sulphate solution, made by adding ammonia to the sulphate and dissolving the precipitate in a very small excess of the precipitant, but was unable to obtain good deposits from sulphate or chloride solutions.

In 1849, Messrs. Woolrich & Russell, of Birmingham, took out a patent for depositing cadmium; they prepared a solution by dissolving metallic cadmium in nitric acid of commerce, diluted with about six times its bulk of water, which they preferred to add at a temperature of some 80° or 100° F., adding the diluted acid by degrees till the cadmium was dissolved. To this solution of cadmium they added a solution of carbonate of soda (made by dissolving 1 lb. of ordinary crystals in a gallon of water) until the cadmium was precipitated; the precipitate thus obtained was washed three or four times with tepid water, when it was ready for use, various solvents being used, but the one preferred was a solution of cyanide of cadmium, which was added in sufficient quantities to dissolve the precipitate and leave one-tenth of the solution in excess. The best working strength for the solution was found to be 6 ounces (troy) of the metal to the gallon, the temperature of the bath being about 80° or 120° F. Bertrand claims to have obtained white adherent coatings from an acid sulphate solution and a solution of the bromide slightly acidulated with sulphuric acid. Cowper-Coles also recommends a strong solution of the double salt of cyanide of cadmium and potassium, as it will deposit the metal rapidly, and in a bright form, a cadmium anode dissolving very freely. Its inertia to chemical action as compared to zinc and brass renders cadmium suitable for coating the terminals and connections of primary and secondary batteries, and for coating small shot (for sporting purposes) and steel bullet jackets, in the one case to prevent the leading of the barrels, in the other the corrosion of the steel. Within the last three years cadmium silver alloys, containing but a small percentage of silver, have been employed for coating the bright steel parts of machines such as bicycles, and a silver cadmium alloy containing 7·5 per cent. of cadmium has been somewhat extensively used for plating domestic articles. Such alloys has been found to withstand the tarnishing influences of the atmosphere much better than pure silver, or a standard silver containing 7·5 per cent. of copper.

A silver cadmium alloy, upon being tested with a Thomson galvanometer, was found to be electro-positive to nickel, there being a difference of more than 0·25 E.M.F., therefore if the alloy is used for coating steel, and the underlying metal is at any time exposed to a chance scratch or abrasion, the corroding action of the air and water is more violent in the presence of the nickel than in the presence of the silver cadmium alloy covering, owing to a more intense electrical action being set up by the nickel. Cowper-Coles's process for depositing the cadmium alloy consists of preparing the electrolyte by dissolving the cyanides of the two metals in cyanide of potassium, the proportions of the two metals being varied with the nature of the deposit sought. To obtain deposits of 10 to 80 per cent. of cadmium, it is found necessary to have the ratio of the silver and cadmium in solution in the proportion of from one to four to one to seven, the best results being obtained when the amount of metal in solution is from 3 to 4 ounces per gallon, and the amount of silver per gallon not less than 8 dwts. or more than 25 dwts.; the weaker the solution the smaller must be the current density employed, and in order to keep the bath from becoming exhausted the anode surface should be greater than the cathode surface, and sufficient free cyanide be always

present in the bath to dissolve the cadmium cyanide formed on the anodes. The addition of the carbonates of the alkali metals is found to reduce local action due most probably to the nascent liberated metal. As the nature of the deposit varies with the current density, attention to the colour and general appearance of the deposit on a test plate or otherwise is found to give full control of the depositing process; an experienced plater can judge the composition of the alloy within 1 or 2 per cent., which is found to be near enough for practical purposes.

THE DOUGLAS AND LAXEY ELECTRIC TRAMWAY.

The Douglas and Laxey Electric Tramway, which was opened at the end of last month, is for many reasons the most noteworthy undertaking of its kind in Great Britain. It is remarkable for introducing into electric traction new methods of design and working, and it is deserving of special commendation for the magnificent coast scenery which it opens up. Tourists and electrical engineers ought to feel the deepest interest in this railway or tramway. The former ought to be gratified because romantic and picturesque scenery has been made accessible to him, the latter should rejoice to see that electricity has been applied with conspicuous success.

The tramway has been specially designed for pleasure purposes, but the inhabitants along the route will obtain for the first time all the advantages and conveniences that a local railway would provide. The only means of communication, other than by railway, hitherto existing between Douglas and Laxey, was by coach or by boat. The coach ran at stated but infrequent intervals, and the boats, save in summer, made no pretence at regularity.

A Bit of Groudle Glen.

It can be safely said that no electric traction scheme carried out in Great Britain, and this means the world, has involved heavier engineering work than the Douglas and Laxey tramway necessitated. The promoters modestly call it a tramway, but to all intents and purposes it is a railway. Certainly, the difficulties of road making and bridge building which were met, are more comparable to the conditions found in railway work than to those of a tramway undertaking. Every foot of the road over which the cars travel has been made by the Tramway Company. The scheme has involved cutting through cliffs; it has in one place necessitated a concrete bed, 18 feet thick, on which the road has been built, and at Groudle it has been imperative that a wide and deep gully should be spanned; the whole length of the line bears evidence of the magnitude of the scheme and the skill necessary to carry it to a successful issue. It says a good deal that the funds for this costly enterprise have been raised for the most part on the island. There were not wanting in the initiatory stages of the undertaking, the carping critics, the pessimists, and the fatuous opposition which wait on all new schemes. There was much objection from the local flymen, who had visions of Othello's occupation gone, indeed, soon after opening for traffic the opposition threatened to assume an ugly form, but time has a wonderful way of breaking the neck of obstruction, and we doubt not that the Douglas and Laxey tramway will ere this have more friends than enemies.

To describe adequately the journey from Douglas to Laxey on board an electric car, would need a more skilled pen than ours. There is an exhilarating feeling to be obtained in a Laxey electric car, which alone is worth the journey from London. The ride is a wonderful opener up of scenery, and real keen enjoyment will be obtained if one does not ask the names of places. So impressed were we with much of the scenery, that we shall be pardoned for reproducing a characteristic piece. From Douglas one ascends the cliffs some hundred feet above the sea, and then come glimpses of rock-bound coasts, romantic glens, then a glorious view of Laxey Bay on the one hand, and Snaefell on the other, and finally we rush down the valley to Laxey Station, and emerging from the cars feel convinced that it is Laxey by the glimmering of the famous wheel in the distance.

It was on the occasion of opening the line for traffic that we first had the pleasure and privilege of inspecting the Douglas and Laxey line. If any satisfaction is to be derived from the fact, we also may claim to have ridden on the second car which made the complete journey from Douglas to Laxey.

The opening of the line was a great day for Laxey, and the inhabitants were determined to honour the event. So the promoters, directors, and engineers made a triumphal entry on board an electric car. The tillers of the soil were there, bronzed and stalwart fishermen, beloved of Hall Caine, workers in the lead mines, indeed, the whole populace was there, and as the car glided into the town under a triumphal arch a great cheer went up, and a local brass band gave in an energetic manner "See the Conquering Hero Comes." It was a conscientious band and possessed a stalwart drummer. In its energy it paid a back-handed compliment to the immunity of electric cars from breaksdown by performing "We won't go home till morning." Small wonder was it that engineers looked grave, and that the local band was shortly afterwards stifled. However, the address was presented without mishap, and after some amusing speeches the ceremony concluded. And now it becomes necessary to be more precise in our language and to give some details of the line.

The Douglas and Laxey Electric Tramway has been constructed under Acts of Tynwald, dated May 30th, 1893, and promulgated on November 17th, 1893.

The Acts were promoted by the Douglas Bay Estate Company, and the line was equipped by them and afterwards sold to the Isle of Man Tramway and Electrical Power Company which was formed in April 1894. This company has also acquired the horse tramway which runs the whole length of the promenade. The chairman of the company is Mr. Alexander Bruce, of Douglas, to whose energy and enterprise the whole thing is chiefly due, the other directors being Mr. Nelson, Dr. Edward Hopkinson, Dr. Farrell, Mr. A. J. Lusty, and others. The engineer of the line is Mr. Frederick Saunderson.

The line extends from Portevada, at the end of the Douglas Promenade and rises up a steep gradient, averaging 1 in 24, up to Lagbirragh, being at this point 258 feet above the sea, the line then turns inland and runs down to Groudle Glen, descending to a level of 128 feet above the sea. Passing the Groudle Hotel, which stands at the entrance to the famous glen, the line crosses a stream by means of a three-arch bridge, 60 feet in height. Then we begin to climb the ascent towards the second Half-Way House, the average grade being 1 in 27, where the public highway from Douglas and Laxey is crossed. We attain here the highest point of the line, 337 feet above the sea level. For some distance after this the line runs adjacent to the public road, but it must be clearly understood that at no point does the line traverse the public roads, it being confined to its specially built track in the same manner as an ordinary steam railway. A stop at the Half-Way House is now no longer a necessity, and we have but a fleeting glance at it as our descent into the valley commences. The driver has perfect control of the cars, and though we make a speedy run on this steep down grade, 1 in 25, the factor of safety is large. The Glen Gawne stream passed we begin another steady rise up to Ballabeg, from whence we obtain a magnificent view of Laxey Bay 297 feet below. A long descent of 1 in 28 commences here, and soon the little white town of Laxey is visible and our journey is at an end.

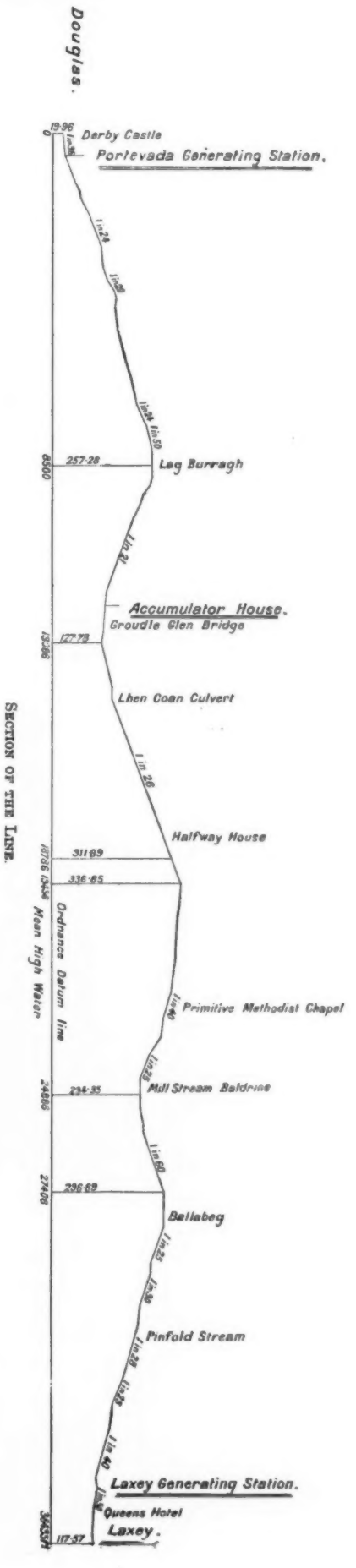
The total length of the line is 36,435 feet, or a little under seven miles. A respected contemporary speaks of it as a small one, but this was contrary to the impression which we received on the occasion of our recent visit, and we must compliment Mr. Saunderson, the engineer of the line, who has carried out the whole of the civil engineering work. The permanent way is double throughout, and is of 3 feet gauge: the width of the cars is, however, a little over 6 feet. It is interesting to mention that a single track to Groudle, about 2½ miles, was completed last year, and cars ran over this short line; the whole of the line has been, however, doubled, and carried on to Laxey within five months. It was obvious that the company were anxious to get some of the summer traffic, and in this they have succeeded.

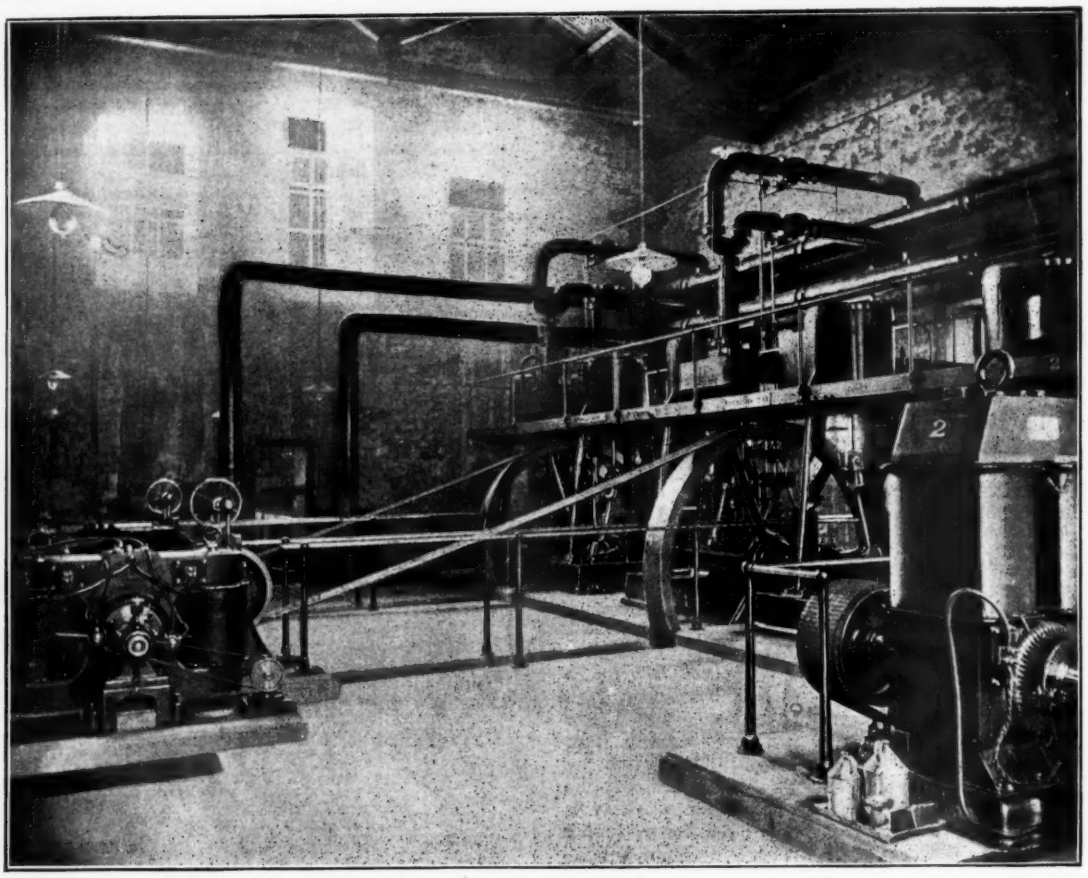
The Electrical Work.

The whole of the electrical plant, boilers, engines, trams and rolling stock have been supplied and equipped by Messrs. Mather & Platt, of the Salford Iron Works, to the designs of Dr. Edward Hopkinson, who has acted as consulting engineer to the company. Messrs. Mather & Platt have been represented on the spot by Mr. P. R. Ramage and Mr. A. P. Wood, who have acted as resident engineers during the construction of the railway.

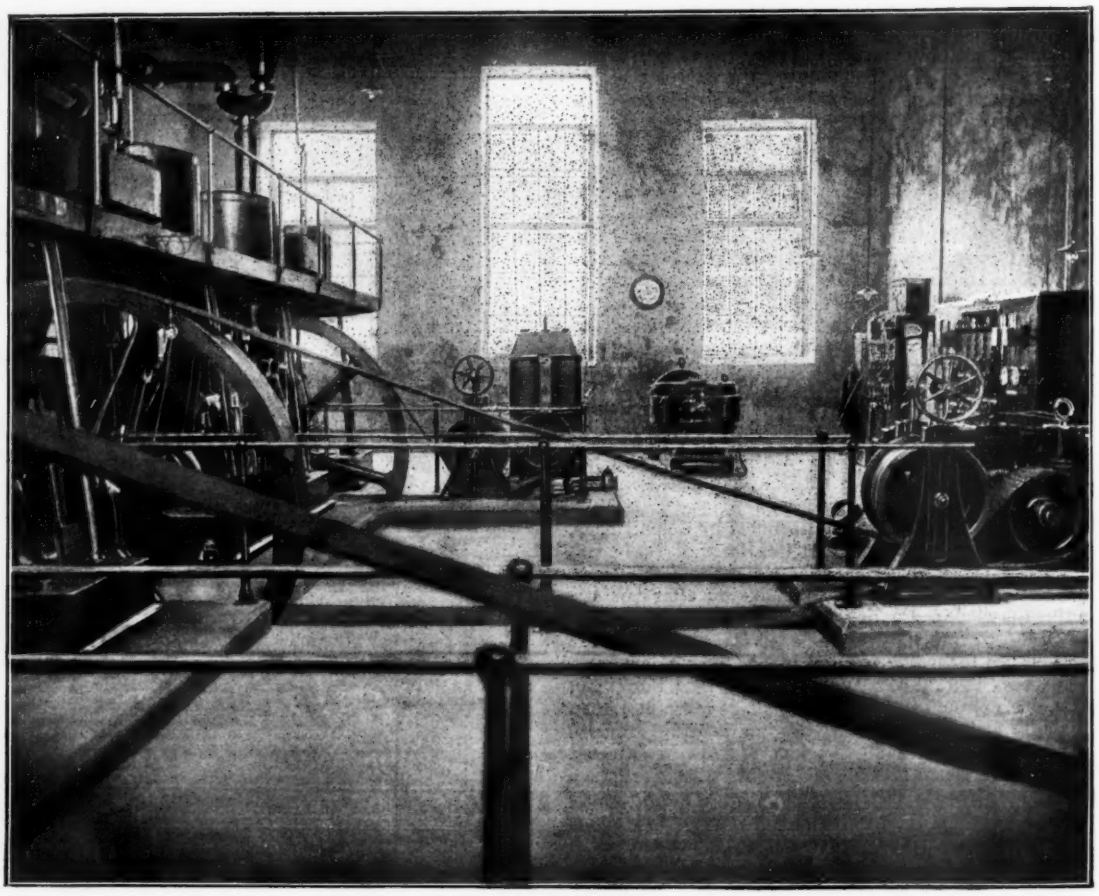
The whole of the line has been inspected by Colonel Rich, late Chief Inspector of Railways for the Board of Trade, and Major Cardew, acting on behalf of the Governor of the Island. The inspection took place on July 27th, and after carefully inspecting the whole of the lines and all the electrical arrangements the inspectors gave their certificate at once and the line was opened for public traffic on the following day.

There are two power stations, one at Portevada, Douglas, one extremity of the line, and the other at Laxey, the opposite end. The former station is equipped with three Lancashire boilers 20 feet long and 6 feet diameter, which work at a steam pressure of 120 lbs. There are three compound side-by-side vertical engines with high-pressure cylinders 10 inches diameter, and low-pressure cylinders 20 inches in diameter, the stroke being 18 inches. Each engine will indicate 100 horse-power, and is fitted with special adjustable governor and heavy fly-wheel. They work on to a separate condenser, and also to a bye-pass for the



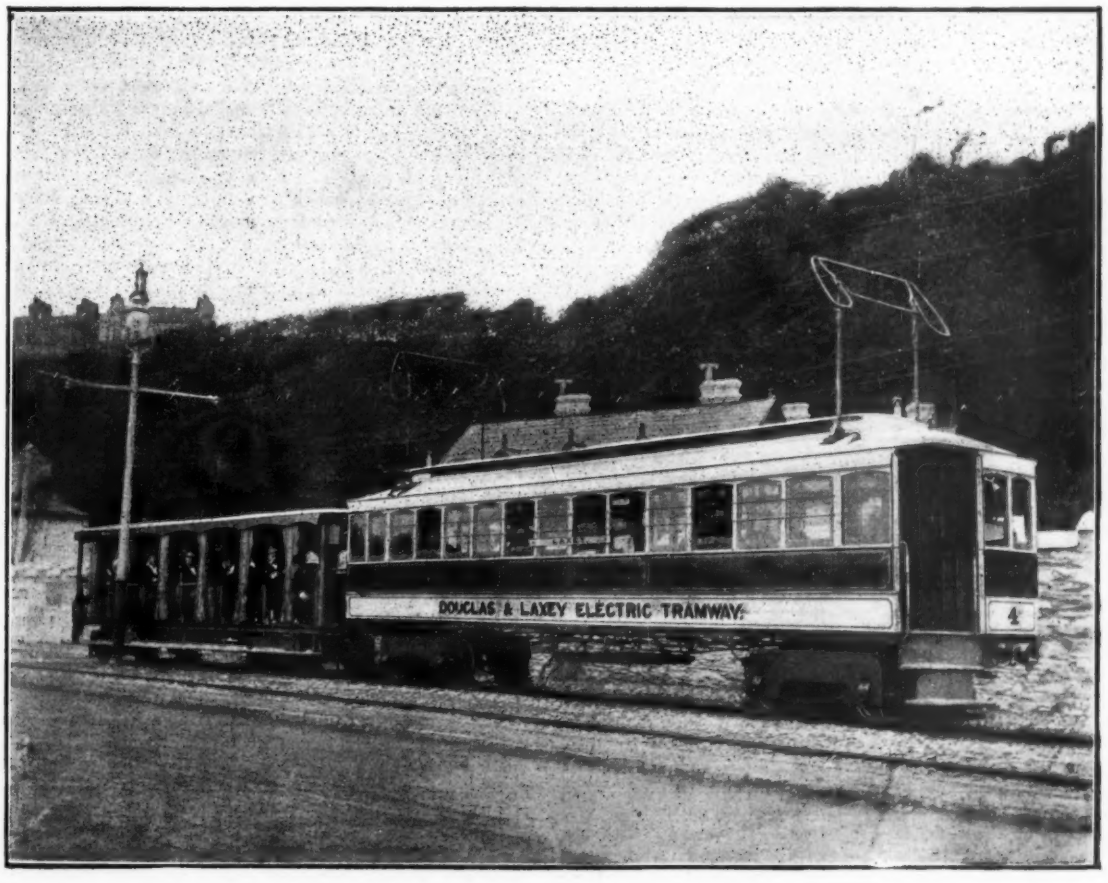


Copyright.] A View of Power Station at Portevada.



Copyright.] Another View of Portevada Station.

View at Groudle, Showing Cars with Old Form of Collector. (*From Photograph taken Last Year.*)



Copyright.] View of Car on Line Showing New Form of Collector. (*From a Photograph taken August*, 1894.)

exhaust to the chimney. The steam pipes are duplicated throughout, from the boilers to the engine cylinders, as well as to the donkey pump and injector.

The condensing water is obtained from a large underground tank, made by building a concrete wall across the creek filled with shingle. An enormous cooling surface is obtained, and, probably, the tank is one of the cheapest ever made.

There is room in the engine house for two more engines. There are two dynamos of the Manchester type, and one machine of the Mather & Platt type. Each machine has an output of 500 volts and 100 ampères, and is driven by link belts with jockey pulleys. The dynamos are connected to the switchboard and so arranged that any of the dynamos can be connected to either the feeder cable or the working conductor.

Each machine has a Thomson electrostatic voltmeter and ampèremeter on its circuit. There is also a subsidiary switchboard for connecting independently from the rails to the earth plates, so that any current returned through the earth can be easily measured. The carriage shed adjoins the dynamo house, but at present is not large enough to contain the whole of the cars and trailers, so arrangements have been made by which trailers can be shunted to sidings some distance on the way to Groudle.

The station at Laxey, hard by the stream which comes from the Laxey wheel, is in most respects similar to the one at Douglas. There are, however, only two boilers and two engines, which drive Mather & Platt dynamos of the same output as the ones at Douglas. Ample room is allowed for extensions, and two more boilers, engines and dynamos can be comfortably housed.

A New Feature.

The feature about the Douglas and Laxey line which will be of most interest to traction men, will be the use that is made of accumulators. At Groudle, which, as we have already said, is distant some 2½ miles from Douglas, the accumulator station is placed. There are 240 cells of the patent chloride type, made by the Chloride Electrical Syndicate. The battery consists of 120 unprotected cells and 120 protected cells with teak and asbestos separators. It is capable of being discharged at the rate of 500 volts at 140 ampères for three hours, or 90 ampères for six hours, or 70 ampères for nine hours. It could also in an emergency discharge at 300 ampères, that is, 200 horse-power for about 45 minutes without detriment to the plates. The battery is usually connected in parallel with the two generating stations on to the line, and charges or discharges according to the requirements of the traffic. It can be brought up to the full charge at any time by a motor generator which is placed in a corner of the accumulator station. It is obvious that only under exceptionally heavy traffic is full benefit derived from the accumulator station. On the occasion of our visit, when, perhaps, fewer passengers than usual were being carried, it being Sunday morning, comparatively little current was leaving the station, and, generally speaking, we should not expect when the power stations at either end are working that there will be much call for power from the accumulator house. But the real utility of the storage arrangements is obtained during the winter months. We have previously mentioned that to all intents and purposes the line has been designed for the purpose of carrying pleasure passengers during the three or four months of the year when the island is given over to visitors. But the Isle of Man authorities in their wisdom insisted that the company should run two cars each way every day of the year. This obligation, while a necessary one, introduced the difficulty of working the system for an infrequent and light demand. Under these circumstances it would have been very expensive, if not prohibitive, to keep a large power generating station running. The accumulator seemed to offer the only method of economically furnishing occasional power, and this is one reason which has led to the Groudle accumulator station. It is proposed during the winter months to rely wholly on the accumulators for supplying power to the line, the battery being charged up about once a week. This will enable a complete shutting down of the plant at the power stations, save for the occasional charging purposes. The working of these accumulators will be watched with the closest interest, both by reason of the comparative newness of chloride cells, and the fact that fixed accumulators have been rarely used to supply power for traction purposes.

The Line.

The working conductors are high conductivity copper wires, No. 0, B.W.G., suspended from steel poles at a height of about 16 feet above the rail level. The poles, fixed midway between the two tracks, have cross arms carrying a conductor on either side over the centre of the track. The working conductor is fed from an underground feeder cable. This has been laid by Callender's Bitumen Company, and is a lead covered steel armoured cable, 37/14s, extending from the generating station at Douglas to the "Half-Way House." Boxes are fixed at suitable points of the line to cut out any section, or to connect the feeder as may be required. The return is by the rails which are bonded by copper strips riveted to the under flange.

The current is taken from the conductor by collectors consisting of two rigid bars carried above the roof of the car; this is a system patented by Dr. John Hopkinson many years ago, but not hitherto applied on any extensive scale. It has the great advantage over the American trolley system that the working conductor can be swung at a less tension, and that the position over the line is of small importance, as the collecting surface is at least six feet. In action it has been found desirable to give the collecting bar some freedom of angular motion to reduce noise and wear and tear. This is done in accordance with a plan patented by Messrs. Mather & Platt, by which the collecting bar can move backwards and forwards through a limited range controlled by springs, thus ensuring continuous contact with the wire, except just at the points when passing under the insulators, when the other collector takes up the current. We give an illustration of a car provided with this hinged collecting bar, which has never before been published; to show the comparison we have also given an old photograph of a car with a rigid bar, which on this railway may be now considered ancient. On no occasion did we detect the slightest sparking from the collectors even on a dark night.

It is the contention of the engineers, and one with which in the main we agree, that with a trolley system it would have been an utter impossibility to complete the line in five months. A trolley wire on the American plan needs most careful erection in order that successful working shall result. The side trolley does not require such nicety of arrangement; but on the whole, the bar collector is perhaps the best form that could have been adopted under the circumstances.

There are nine motor cars and 12 open trailing cars with light roofs. The motor cars have longitudinal seats and seat comfortably 38 passengers, the trailers have transverse seats and carry 44 people. All the cars are fitted with powerful brakes controlled from either end, there is also an emergency brake available in case of accident to the main brake. This is automatic in its action, and if a trailer, when going up a gradient, should part from the motor car, it will instantly be brought to a standstill. It might be added that at the inspection by Colonel Rich and Major Cardew referred to, this brake was specially tested, the couplings between the trailer and the motor car being repeatedly broken, but on no occasion did the brake fail to act instantly. This automatic brake is the patent of Messrs. G. F. Milnes & Co., of Birkenhead, who, by the way, supplied all the cars.

There are two motors on each car with helical steel single reduction gear. The motors are designed together to give 3,000 pounds tractive force at the periphery of the wheels. The motors are of the usual series type; carbon brushes are used and are said to give little trouble, save that which occasionally arises from an undetected inferiority in the carbon. The regulating and reversing switches are fixed at each end of the car, the resistance frames being carried underneath the bogies. The reversing switches are for the most part of the barrel shape, that is, they consist of a wooden cylinder having contact pieces placed on the surface. They are worked by a handle in the usual way. There is, however, no uniformity in the switches, the intention being, no doubt, to test the various forms. It might be added that the drivers, many of whom were quite new to the work, managed the cars with the greatest ease and never appeared to be at a loss as to the proper thing to do. They, perhaps, err a little on the safe side, but strict instructions are given to each driver to keep a steady speed. For some reason or other the authorities insist that the speed shall not exceed eight miles an hour,

and four miles an hour when crossing the public roads. This is a curious regulation when it is remembered that the road on which the cars travel is a private one. Still an insistence on this will do no harm. It might be mentioned that each car is lighted by incandescent lamps, and has also a powerful searchlight in front. The steadiness of the potential throughout the line is proved by the perfect burning of the lamps.

The power station at Douglas is also used for lighting some of the adjoining buildings, including Derby Castle, a popular theatrical and dancing place; a large new hotel called the Douglas Bay Hotel, is also fitted with 250 incandescent lights supplied by a motor-alternator driven from the power plant. A portion of the new roadway over which the cars travel is lighted by arc lights, the lamps being placed on the top of the poles carrying the conductors. It is exceedingly probable that this branch of the company's business will be an extended and profitable one.

Returning, however, for a moment, to the prospects of the line, the promoters are sanguine that financially it will be a marked success. They do not deny that it has been an expensive undertaking, something like £150,000 having been spent, but they hope with the enormous number of visitors which yearly visit Douglas that they will obtain a fair return; already 30,000 passengers have been carried in one week. No doubt the line will, to a great extent, develop Laxey, which is a charming but has been hitherto a somewhat inaccessible place. It is proposed to carry light merchandise by the line, and this in the winter months may be a source of profit. That there are some difficulties in the way is not for a moment denied. The bulk of the work falls on four months of the year, and to meet the conditions of a large traffic during this period a large staff is necessary. When the season is at an end, there must be a difficulty to find employment for this staff; it would, of course, be out of the question to turn the drivers and conductors adrift in the hope that they would return in the summer months. They become practically trained men, and it is necessary for the successful working of the line that their services should be retained. However, the development of the lighting branch of the business may, to some extent, afford a solution of the question.

We think that all concerned are to be congratulated on the remarkable success which has been achieved. Messrs. Mather & Platt, Mr. Saunderson, and Dr. E. Hopkinson, are deserving of special commendation.

In conclusion, we beg to thank these gentlemen for the help which they gave to our representative on the occasion of his visit to the Isle of Man.

ELECTRIC LIGHTING AT ARUNDEL CASTLE.

Great and permanent improvements are being rapidly effected by His Grace the Duke of Norfolk at Arundel, in many of which the public take, and hope always to be permitted to take, a warm interest. The work of rebuilding the Castle is steadily proceeding, and, as the local press has it, "Arundel has been the scene of an invasion of the skilful and the capable such as no other town of its size has known. Imported intellect, so to speak, has been working its will within the boundaries of the little borough, and its long-brooded thought is now being born into the light of day."

When complete, the Castle lighting will be one of the most important and efficient private installations in the kingdom, although, at present, it is, in what may justly be termed an experimental stage, so far as the style of the lamp fittings and their positions are concerned. But sufficient has been done at the generating station to justify the publication of a special notice.

About the beginning of 1890 Mr. Gisbert Kapp, who, as our readers are aware, has just left England for a lucrative and congenial appointment in Berlin, much to the regret of his English friends, was, through the instrumentality of Mr. Arthur F. Phillips, C.E., consulted by the Duke of Norfolk on general grounds regarding the electric lighting of his beautiful and picturesque Sussex seat. Mr. Kapp made a report without entering into minute details, that some 1,200 lamps of 16 candle-power would be required, and he advised the continuous current low tension system.

It may be interesting here to state that when the lighting of the Castle by electricity was first considered, each contractor was asked to propose his own plan for the most effective internal service. On the part of His Grace no definite instructions were given as to the details of the lighting. The contractors were called upon to present their own schemes for internal lighting, and to stand or fall by them. When all the plans had been received they were entrusted to Mr. W. H. Preece, C.B., F.R.S., and his award was accepted.

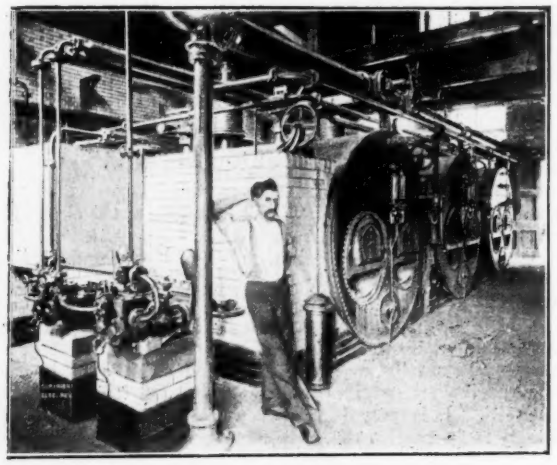
The tender of the Brush Electrical Engineering Company was the successful one, and it was altered and modified by Messrs. Kapp, and the Duke's engineer, Mr. Arthur F. Phillips, C.E., to suit His Grace's requirements. The station building and the general arrangements of the plant have been carried out according to the designs of Mr. A. F. Phillips, Mr. Gisbert Kapp acting, until his departure, as consulting electrical engineer throughout. Mr. A. Bard, C.E., has acted as the resident engineer. The contractors for the buildings were Messrs. Reed, Blight & Co., Limited. The whole machinery and electrical plant has been supplied and fixed by the Brush Electrical Engineering Company, Limited, London, under the superintendence of their engineer, Mr. W. Geipel, M.I.E.E., who has also laid the cables and carried out the wiring of the Castle, and Mr. J. E. Sayers is in charge of the electrical section.

On August 7th a few friends of Mr. Kapp, and of the contractors, were invited by the Duke of Norfolk to lunch with him at the Castle, and afterwards inspect the installation as far as it had progressed, and we will now give a general description of what has been accomplished during the past 18 months, and we begin with the building, which contains boilers, engines and dynamos, and the secondary batteries. It is erected in the New Road, at the top of Poor House Hill—to give the lane its old name—and near the entrance to the Castle gardens. The building, which was commenced in 1893, is hidden from the road for much of its height by the familiar wall, so that the passers can only see its upper part, though this is sufficient to indicate the scale and quality of the work. Throughout, the aim has been to make the installation perfect, if not unique, and to provide for that installation a home not only adequate and meeting all utilitarian demands, but in itself, so far as this is possible, invested with the charm of art. These (and here, again, we are pleased to quote from the local press) are the characteristics of all work undertaken by the Duke of Norfolk. Outside and inside, the building—half engine-house, half villa residence—attracts by its stability, and charms by its grace and

Arundel Castle Electric Lighting Station.

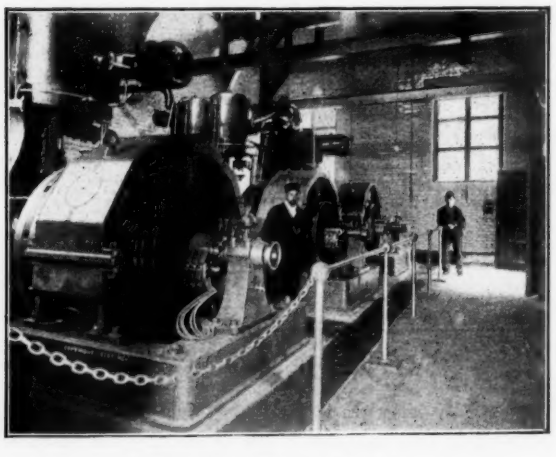
finish. It has been designed in what may be termed the Elizabethan domestic style, with perpendicular reminiscences, and is intended to look as little as possible like the normal engine-house. The shaft here is octagonal, and only 46 feet in height. Old English oak, obtained with great difficulty, has been used everywhere externally; the roofs are of pitch pine, and covered with Ruabon tiles. Internally the rooms —there are four of them—are lofty, well lighted, and look the picture of cleanliness and utility.

The brickwork outside is of a dark red colour, but internally the 18-inch walls are lined with a green grey glazed brick, chamfered on the edges, which has been specially made at Farnley for this work. This light glazed brick, suitably set off by a chocolate moulded skirting, and running up into the elaborate lofty queen or king post roofs, gives all the rooms a delightfully cool and bright appearance. The doors are all of oak, strongly framed with chamfered edges; the lintels and sills are of Portland stone, and the floors are paved, two with geometrical tile paving, and two with Staffordshire bricks. The building has a total frontage of 92 feet, with a depth of 48 feet, and is 36 feet high. It comprises boiler house, engine room, accumulator room, and fitting shop.



Boiler House.

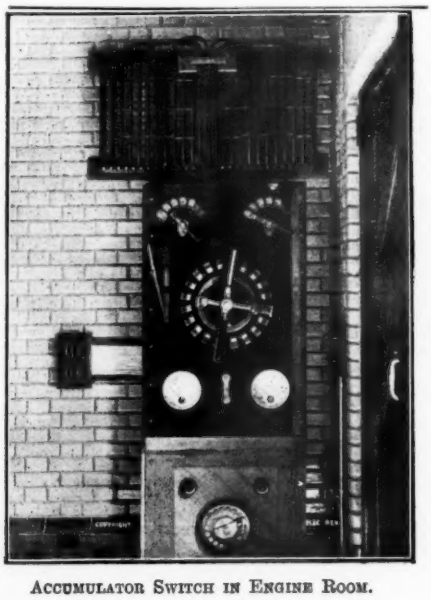
In the boiler house, which is 45 feet by 31 feet, are three Galloway steel boilers, 18 feet long by 6 feet 6 inches diameter, with two flues, and each enabled to make steam of 3,300 lbs. of water per hour. They are solidly set, so to speak, in a parallelogram of the attractive grey brick, and are fed by two steam feed pumps, either of which is capable of supplying any two of the boilers. An Atkinson's feed water heater, heated by the exhaust steam, flanks the boilers, and, to an extent unusual even in otherwise perfect plants, a steam main of wrought iron, copiously valved, enables steam to be ob-



Engine and Dynamo House.

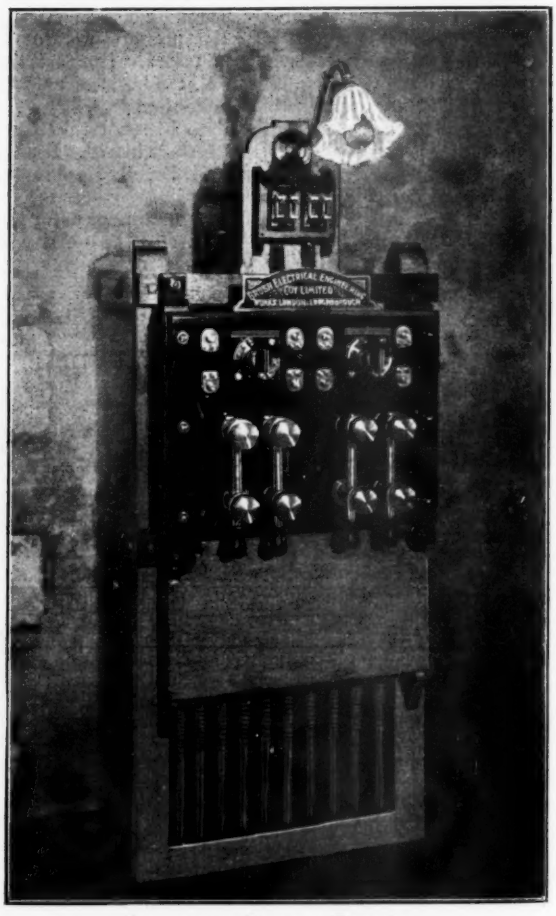
tained from each, any, and all of the boilers. Here, as elsewhere in the lighting plant, a complete system of duplication has been adhered to, so that no breakdown within the limits of probability will bring matters to a standstill. If there is little that is absolutely novel in the steam plant, there is nothing new and good which has not been adopted.

Passing to the engine house, 36 feet by 24 feet, we find three 90 horse-power vertical inverted compound double-acting steam engines of the Brush-Falcon type. The cylinders are 12 inches and 20 inches × 14 inches stroke, and the speed is 140 revolutions according to conditions as explained below. To each is coupled direct a specially com-



Accumulator Switch in Engine Room.

pounded self-regulating dynamo. The engines and dynamos are mounted on strong bed plates, set on a massive foundation of cement concrete. On the wall, facing the



Distributing Board in Dungeon.

engines, is the main switchboard, with switches for working two or three dynamos in parallel or singly, together with ammeters and voltmeters, and other measuring instruments.

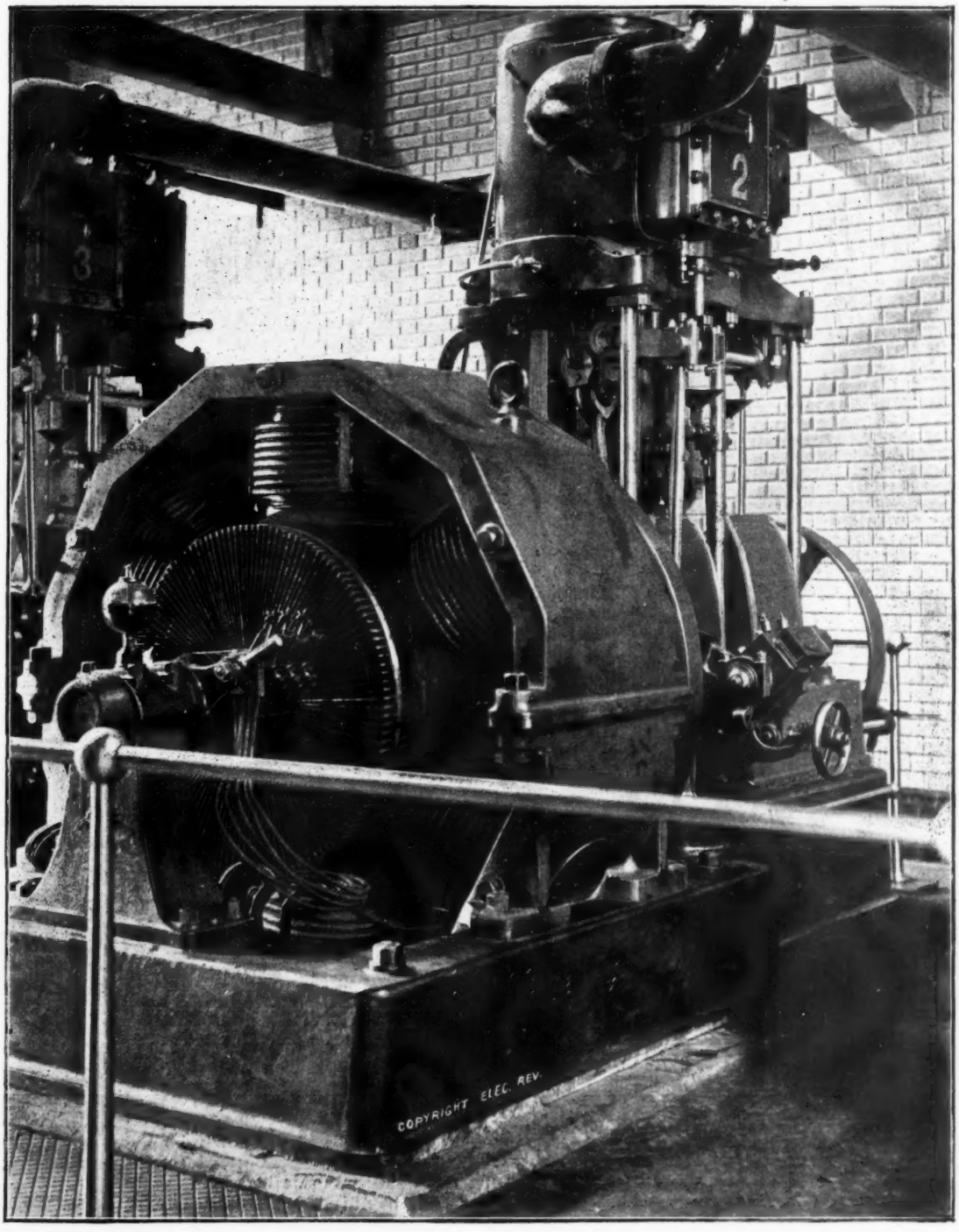
On the main dynamo board there is for each dynamo a large circular switch which has the three positions of "lighting direct," "off," and "charging," and it is so arranged that all the necessary connections are made in either case by the movement of one handle.

Below the main switches are rheostats for controlling the dynamo fields when the machines are running in simple shunt, charging cells, and these rheostats are connected with links to the main switches in such a way that if by accident the main switch were changed over from charging to lighting, the whole resistance of the rheostat is inserted, and the danger of putting the high charging E.M.F. on to the lamps, avoided.

It is evident that if two machines are compounded for *external loss* (commonly called over-compounded) in the ordinary way, these two machines, when put in parallel, will only give an extra voltage corresponding to the load of one (*i.e.*, approximately half the total), whilst the loss in the mains, for which it is desired to compensate, is that due to the total current.

To get over this difficulty the machines at Arundel have the usual series winding for approximately constant potential at the terminals, and in addition an *extra series* winding coming from the omnibus bar and carrying all the current which is going to the mains, and by this means an extremely constant pressure is maintained at the Castle under all conditions of load.

The machines are of the multipolar type, each having eight poles, with drum wound armatures, and fitted with Kapp segmental connectors.



[Combined Dynamo and Engine.

Each machine is capable of working up to 64 kilowatts at a pressure of 160 volts when used as a simple shunt machine for charging accumulators at a speed of 140 revolutions per minute, and up to 51·2 kilowatts at 128 volts when used as a compound dynamo supplying lamps direct at about 120 revolutions.

The compounding has been specially designed to give the required pressure at the Castle voltmeter board within an error of two volts up or down between no load and full load, that is, the dynamos have, in addition to the ordinary compounding, an extra compound winding in series with the main circuits, thus compensating for the loss in the mains, whether one machine is running alone, or two in parallel.

Each machine is mounted on an extension of the engine bedplate and is direct coupled to its own engine running at the speed above mentioned.

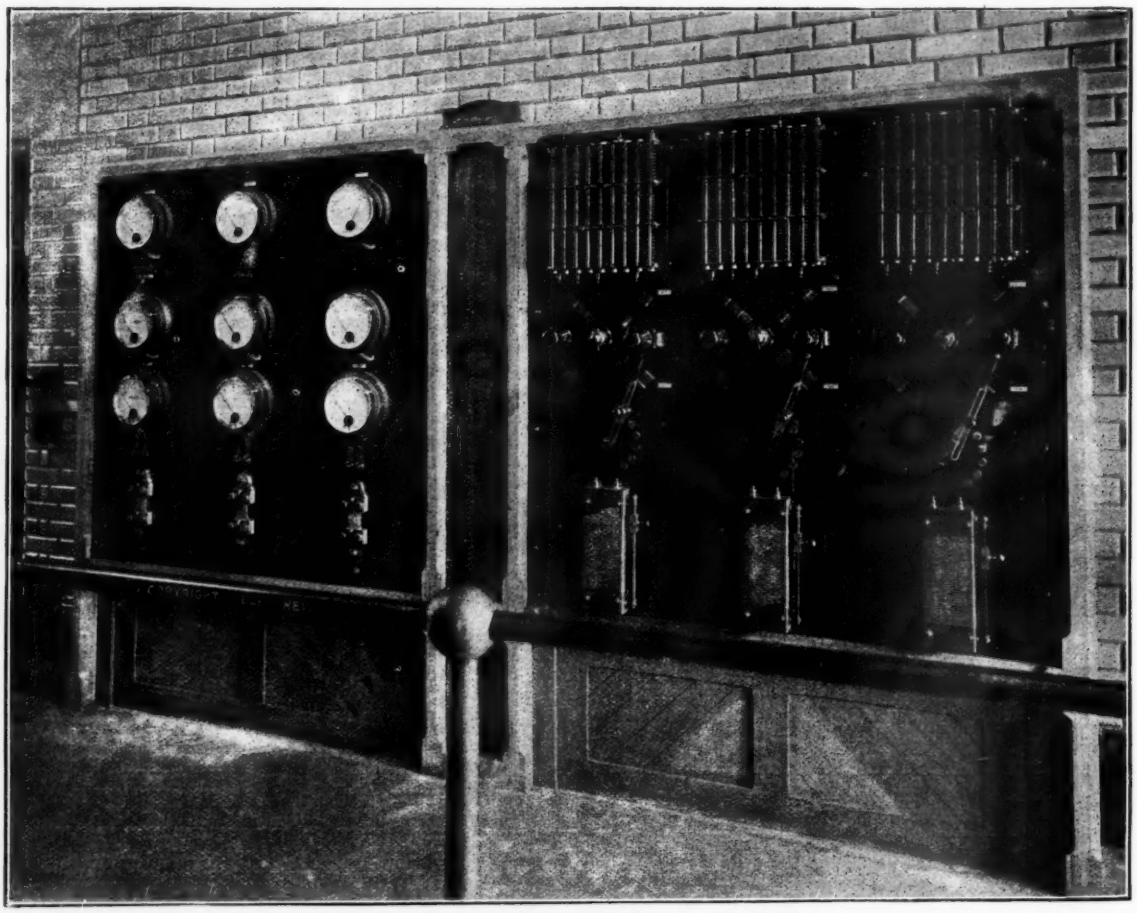
The current is collected from the commutator by two sets of three two-inch wide brushes, each having independent adjustment and hold-off catches.

The engines are fitted with Raworth's patent expansion governor, adjustable by hand whilst running from about 120 to 140 revolutions, to enable the same machines to run compound direct on the lights or as simple shunts to charge cells.

The accumulator room, which is 31 feet long and 18 feet wide, contains two sets of storage batteries, each consisting of 62 cells of the D.P. type, H size, made by Messrs. Johnson and Phillips, and together capable of sustaining 260 lamps of 16 candle-power for 10 hours or 440 for 3½ hours. The batteries are charged in parallel, and the charging is equalised in each set by a rheostat in its circuit. None of the lighting cells are ever cut out of circuit; their E.M.F. is controlled by inserting a more or less number of opposition or back E.M.F. cells composed of plain lead grids, and it will be seen that as the current always passes through them in one direction only, they are always well formed and capable of giving an opposing E.M.F. on the line when required.

The only other room in the building is what is called the fitter's room—a term which sufficiently describes its purpose. Through openings in the wall fitted with removable shutters it is possible to readily get to the backs of the switchboards, a great convenience.

The feeders between the generating station and the distributing room (which is situated in the old dungeon tower) consist of two pairs of cables, each cable having a sectional area of ·80 square inch. The distance is 440 yards. The cables are arranged so that they can be readily interchanged at either end of the line. In the dungeon, the two pairs of mains are brought up to a distributing board and each cable is connected to a plug switch by means of which, and an exactly similar arrangement at the generating station end, the interchange of cables just referred to may be effected. Each pair of cables of similar polarity are connected by means of their plug switches to their corresponding cables of a ring of equal cross-section to the feeders, which runs round the Castle courtyard and from which the Castle lamps are fed at five points round its length.



Main Switchboard in Engine House.

From this board also two pairs of cables are taken to supply (*a*) all outside lamps and (*b*) lamps in the lodge at the entrance to the main drive.

The board is so arranged that all cables are accessible from both the front and back.

From this distributing room a ring main is laid round the Castle courtyard, the length being about 270 yards. It is connected at each of its extremities with the switchboard in the distributing room. This ring consists of a pair of cables having a section of ·80 square inch, tapped at five points, from which branches are run into the service switchboards placed in the corridors within the Castle. The insulation resistance of the large wires, when tested by Mr. Kapp, considerably exceeded the figures required by the specification, and the ring mains gave over 100 megohms, so Mr. Callender may be well satisfied with his share of the work.

A pilot wire is built up inside the main cable, and in addition to this a separate cable for indicating pressure, or for signalling, having three conductors, each 7/22, is laid from the generating station to the distributing room, and connected thence to one of the Castle switchboards.

The main cable is formed of 60 wires, each No. 10 S.W.G., and is insulated by bitumenised fibre. This is sheathed by a heavy tube of lead, which is protected by thick servings of yarn, dressed with preservative compound. The cables are laid direct in the ground under the turf and garden paths of the park, and planks are laid over them so that they are quite free from all chance of injury. Halfway between the generating station and the distributing room boxes have been placed, so that the mains can be disconnected for testing. Branch mains are also laid from the distributing room to the lodge, and for supplying the large incandescent lamps which will light the drive to the Castle. The inside wiring is all done with circuit distributing boards in which all fuses are grouped. No more than seven lamps are on any one fuse, and in most instances the number is less. The boards are sunk in wall recesses, covered with oak doors, the fuses and switches being numbered inside, with a schedule pasted upon each door giving information of the room to which it belongs. It was specified that when all the lamps were alight, the fall of potential between the ring main and the farthest lamp should not exceed 2 volts, and Mr. Kapp's tests showed that the biggest drop was 1·8 volts, the majority not giving more than 1·5.

We have said nothing regarding the fittings or the effect of the lighting, for the simple reason that everything is in a tentative state. It would have been quite impossible to select the best combination of fittings and lamps without considerable experimenting, and His Grace is therefore very wisely making numerous trials in order to arrive at the best, most artistic, and most suitable means of lighting the various rooms and apartments of the Castle, and for this purpose some 600 lamps are being fitted up temporarily.

We have to thank Messrs. Kapp, Phillips, Geipel, Sayers and others for assistance in compiling this article; also to congratulate the Duke of Norfolk that his work has been placed in such very capable hands. Doubtless, when the installation is complete, we shall be able to supplement this preliminary notice with another.

CHEAP TELEGRAPHY.

The interesting series of articles on "An Ideal Post Office," which has been appearing in the *Pall Mall Gazette*, has, doubtless, been followed with great interest by many. In article VIII., telegraphs, cables, and telephones are dealt with, and there is a tempting statement of what might be done, or rather of what ought to be done (according to the writer) which makes one think that it is a pity that it is not done. We do not go so far as to say that the writer is quite incorrect in the ideal that he puts forward, but at the same time he gives practically no facts to substantiate his theories. It is all very well to talk about "cables being strictly reserved for the wealthy" in a tone which indicates great indignation that it should be so; the same might be said of many other things; the whole question is whether the financial status of the nation will allow the ideal to be carried out. Let estimates at least be put forward to show that telegrams at 6d. per word to all the colonies (as advocated) can be made a feasible arrangement. Not that estimates are altogether to be relied on; we know pretty well what was prophesied in regard to the 6d. inland rate; certainly it was not imagined by those who forced the same on the Government of the day that the result would be that the expenses would exceed the receipts, but such has nevertheless been the case. It may be that in the acquisition of the telegraphs by the State, the latter "first made a wasteful bargain and then suffered loss of revenue." This does not affect the question that the prophecies, or rather estimates, regarding the 6d. rate have not been fulfilled. There are, doubtless, many practices in the administration of the whole postal telegraph system which seem little less than idiotic and which require reform; these have been often exposed, and are again so in the *Pall Mall Gazette* article, but it by no means necessarily follows that there is no method in the madness, simply because outsiders cannot see it. But, apart from all this, the financial question remains and has to be dealt with; the securing of cheap this or cheap that for the nation is often equivalent to endeavouring to get the "axe ground for nothing," or being generous at the expense of your neighbours.

The question of securing the telephones for the nation has been more than once dealt with in the pages of the Review; indeed, we return to the charge again this week. With reference to this the *Pall Mall Gazette* says:—"The question of securing the telephones for the nation is one of the gravest moment; and, unfortunately, it has to be decided at a time when men's minds are absorbed in political controversy. The state of affairs is shortly this: One association, the National Telephone Company, owns nearly all the wires and exchanges in the towns, and transacts 95 per cent. of the business. The Post Office has rival telephones, but attracts little custom, and finds its revenue from telegraphs rapidly declining. It has, therefore, persuaded the Government to set aside a million for the purpose of buying the existing trunk lines (of the company) connecting various towns, and of constructing new trunk lines. As has been pointed out, this will be a worse bargain than was entered into on purchasing the telegraphs. All the remunerative business will be left to the company, while the Government will pick up the bones which the company flings to it. The profit of telephony, as of telegraphy, or postage, or any other business is made in the large centres of population, and this profit the Post Office ought to secure for the benefit of the tax-payers. If the company (or companies) did the work well and cheaply, there would be less to complain of. But by the confession of the chairman of the National Telephone Company, this is not the case. He admits that the service is defective, and lays the blame on the owners of property, who will not facilitate the necessary works of construction and repair. While private monopolies are concerned, there will always be friction and defective service. The obvious duty of the Government is to assert its monopoly for the public benefit, and acquire the property of the companies before its constant development shall make the cost prohibitive. In place of paying from £12 to £20 a year, the charge for a private telephone should not exceed £3 to £5 a year. In the Australian cities of Melbourne, Adelaide, and Sydney telephones are in the hands of the Government, and the charge in Adelaide is only £6 a year to subscribers."

THE BRITISH ASSOCIATION.

HOT *v.* COLD WALLS FOR STEAM CYLINDERS.

On the 11th inst., before Section G, Mr. Bryan Donkin read a paper on the most economical temperature for steam cylinders. Though a valuable contribution, the paper does not in reality make any attempt at determining the most economical temperature, nor does it, though, of course, its author thoroughly understands that cylinders must be hot to secure anything good in results, sufficiently recognise in its style that this is an accepted and proved fact. Instead, the author insists upon calling attention to the importance of the subject, much as though he had only just found it out himself, and was anxious all should know. In most engines the cylinder walls are, he says, much colder than the entering steam, and from 40 to 50 per cent. is promptly condensed; but if the walls are hotter than the initial steam, condensation is *much reduced*. Now, has Mr. Donkin any experimental proof to offer us that any steam is condensed by a cylinder wall hotter than the initial steam? Unless he has, the italicised words above should surely have read *entirely eliminated*. We are all quite prepared to hear that years of experiment have shown the author that the best results are obtained the nearer the wall temperature rises to that of the steam, and that where the difference is 40° to 60° F., steam consumption is greatly increased. It is to a perception of this fact that believers in compound working have long ago ignored the claims of the simple engine to be as good as the compound, on the ground that it did not matter whether expansion was carried out in one cylinder or more. Of course it did matter, and the compound engine proved its right to exist, and now the theorists are preparing its theory to fit what facts have established.

Mr. Donkin thinks cylinder walls may be too hot—a condition however, seldom found in practice, though he would always allow them to be something hotter than the initial steam, and this is as far as he goes in determining the most economical temperature, which probably would be found to be different in every cylinder, and to depend upon the speed, cut off and dimensions, so as to be practically a non-calculable quantity. We certainly think that no wall has

reached its maximum economic temperature until it has passed the boiler temperature, and it is for this reason, as well as for the certainty of preventing the reduction of jacket efficiency, that the writer has always advocated the putting down of a special boiler of higher pressure, the whole of the steam from which shall pass *via* the jackets into the main boilers through a reducing valve, and, of course, superheated steam, which can heat up the walls without itself condensing, no doubt better performs the same duty.

Mr. Donkin has applied himself to finding the temperature of cylinder walls, but hopes future experimenters may be able to take the temperature as near as $\frac{1}{4}$ mm. from the inner surface; as it is, in quick running engines, only a fractional thickness that fluctuates through the whole temperature range of the steam, often 100° to 150° F. per stroke. His own method has been to drill holes of $1\frac{1}{2}$ mm. diameter into the cylinder walls and covers. These are 3 inches long and filled with mercury, into which small thermometers of 1 mm. diameter are introduced. In any working engine it is found that the cylinder wall may be divided into two parts, an outer portion wherein the temperature is constant, and an inner portion which is called the "periodic" portion, as it is affected by the temperature variation per stroke. In the outer larger portion, the thermometers will, of course, give correct readings, but in the inner periodic the readings of the thermometer will be over a less range than the actual, tending nearer to a mean the more rapid the stroke alternations, and only reaching to the full range in slow moving engines.

Thus in a non-jacketed engine at 35 revolutions with walls 1 inch thick, the temperature at 8 mm. from the internal surface was constant, but at $1\frac{1}{4}$ mm. the mercury rose and fell regularly. On the walls of a non-jacketed vessel, with walls much colder than the steam, drops were formed, even as large as 4 mm. diameter, but on a hot jacketed wall they never exceeded $\frac{1}{4}$ mm. Time is, of course, a factor, the same engine at 220 and 117 revolutions showing an economy of 11 per cent. at the higher speed.

For purposes of experiment a single cylinder engine, 6 inches by 8 inches stroke, was designed specially, and was arranged so that the cylinder wall temperature could be varied considerably. It could be run condensing or high pressure, single or double acting, and with or without jackets, with either saturated or superheated steam in them. One set of conditions only was varied at a time; obviously the small size of the cylinder was favourable to the exhibition of large results from small differences of temperature by reason of the very much greater ratio of metal to steam that exists in small than in large cylinders, the surface increasing simply with the diameter as regards the barrel surface, while the steam capacity varies as the diameter squared, while the ratio of piston and cover area to steam weight may be taken to vary as the stroke; a large cylinder carrying a greater capacity of steam than a small one per square inch of area.

The experiments cannot, therefore, be taken as a guide to practice in ordinary sizes of engines, but are simply indicative of the direction in which cylinder condensation works, and the limits which it places on expansion. Thus in the first series of experiments with cylinder unjacketed, double-acting condensing at 220 revolutions, the cut-off was varied from $\frac{1}{12}$th to $\frac{5}{16}$ths, and the steam per horse-power was respectively $43\frac{1}{2}$ lbs. and $35\frac{1}{2}$ lbs., the temperature range being 135° and 128°, and the I.H.P. $4\frac{3}{4}$ and $7\frac{1}{2}$. The wall temperature, from being 233° in the first case, rose to 264°, owing to the greater weight of steam passing at $2\frac{1}{2}$ than at $5\frac{3}{4}$ expansions. This shows that the temperature difference of the steam and cylinder wall was reduced from 65° to 31°, and the rate of condensation per square foot hour diminished from 515 lbs. to 264 lbs. This, it may be remarked, is in fairly close agreement with the temperature differences. This produced an economy of steam (per I.H.P. hour) of $18\frac{1}{2}$ per cent., and an improvement in the thermal efficiency from 5·3 to 6·6 per cent., or 25 per cent. The annexed table gives the figures for several experiments, which all point to the same conclusion, and also, experiments in which the expansion was much varied with and without jackets, and the hotter walls always gave a better efficiency, as might have been expected, and as James Watt plainly perceived. Some other experiments, made in cast-iron vessels about $5\frac{1}{2}$ inches diameter, were for the purpose of finding the rate of condensation per square foot. With superheated steam in the jacket at 348°, only 1·3 lb. per square foot hour were condensed, but with a wall temperature of 218°, and saturated steam inside at 297°, the wall being colder by 79°, the condensation was $43\frac{1}{2}$ lbs. per square foot hour.

Varnishing the walls reduced condensation, and the heat penetration into the wall varied always with the wall temperature difference.

The conclusions are drawn that the temperature range has less influence on steam consumption than the wall temperature, that wall temperature has a greater effect on small than on large cylinders, and that speed, by increasing the weight ratio of the steam to the cylinder internal surfaces, is favourable to economy.

So far as we can reason from the particular case to the general case, it would appear that, in designing a steam engine, the first care must be to keep the cylinder as hot as the entering steam; the next care to reduce the range of temperature; and, thirdly, to pass as great a weight of steam as possible through the cylinder.

To secure these results, we have, first, a small cylinder to take the hottest steam, and being small it is easier kept hot, and has smaller radiating surfaces. We have, next, more than one cylinder to reduce the range of temperature, and thereby avoid too great a heating of the exhaust steam. In a compound engine it is true the re-heated steam is used again in the later cylinders, but this is bad in so far as such heat is apt to be stolen from the initial steam of the previous cylinder.

Increase of weight ratio is simply got by high piston speed, and the capacity of a cylinder for steam is better obtained by length than by diameter, for an addition of length only adds surface on the cylinder body. An increase of diameter adds to two other surfaces, the cover and piston. So far as these reasons indicate there is less advantage in high reciprocation than in high piston speed, unless the high reciprocation gives the same piston speed. The object is to increase the weight of steam used per pound of cylinder metal, or more particularly per foot of internal area of cylinder, &c.

As a matter of direct practical application the experiments show convincingly the propriety of working small engines at late cut off, and the uselessness of attempting to secure economy in such engines by cutting off. In other words, keep small engines small enough, and jacket them if this is at all possible, but do not attempt to secure economy by much expansion. Even when engines are large it has been recognised for many years that for simple engines an expansion of six times is as much as economy will allow. That somewhat higher expansions were, perhaps, found economical at sea is probably due to the two facts that marine piston speeds were higher than land speeds, and cylinders, as a rule, were much larger, and hence the ratio of steam weight to internal surfaces was greater in the case of most marine engines. There is little doubt but that more definite information would have ere this have been obtained as to the influence of jacketing had it not been for the very faulty construction of so many of these appliances.

Without circulation, placed at the highest point in their pipe connections and filled, therefore, with air, or in other cases undrained and full of water, jackets have been condemned as useless. Without saying that there are not cases where the influence of jacketing is bad in an economical sense, we think such cases would often, at least, be found to be cases of heavy priming, and it has been laid down that jackets are wasteful only when the cylinder is so wet as to throw upon the exhaust stroke the duty of evaporation—not simply the duty of re-evaporation of steam condensed in the cylinder, but the actual evaporation of water that never has been steam at all, but is simply primage from the boiler, and we must confess to grave doubts of all jackets through which steam does not flow positively, as it would do from a special high pressure boiler to the main boilers, whereby also the jacket would have a temperature greater than the working steam. But what is to be said of the thousands of steam cylinders that are jacketed with exhaust steam by means of the exhaust passage from the slide valve face? There are cylinders supposed to be steam jacketed that have also the exhaust jacket as above, and what can be worse than damp steam as an absorber of heat from the cylinder walls. Progress has been made in large and in high class

Series.	Pressure.	Revolutions.	Double or single acting.	Jacketed or not.	Condensing or not.	Cut off.	No. of expansions.	Steam per H.P. hour.	Temperature range of steam.	Indicated H.P.	Weight of steam per hour.	Wall temperature.	Initial difference of temperature.	Rate of condensation, square foot hour.	Economy of steam by variation.	Percentage thermal efficiency.	Gain, per cent.
1 *a*	50	220	D	N	C	$\frac{1}{12}$	$5\frac{3}{4}$	$43\frac{1}{2}$	135°	$4\frac{3}{4}$	184 lbs.	233°	65°	515 lbs.	...	5 3	...
1 *b*	50	220	D	N	C	$\frac{5}{16}$	$2\frac{1}{2}$	$35\frac{1}{2}$	128°	$7\frac{1}{2}$	269 lbs.	264°	31°	264 lbs.	$18\frac{1}{2}$	6·6	25
3 *a*	,,	,,	,,	,,	N	$\frac{1}{8}$	$4\frac{3}{4}$	62	85°	3	183 lbs.	246°	54°	440 lbs.	...	3·8	...
3 *b*	,,	,,	,,	,,	N	$\frac{3}{4}$	$1\frac{1}{4}$	41	,,	8·4	373 lbs.	282°	16°	105 lbs.	$28\frac{1}{2}$	5·4	42
4 *a*	,,	227	S	,,	C	$\frac{1}{8}$	$4\frac{3}{4}$	56	equal	2	110 lbs.	233°	73°	576 lbs.	...	4	..
4 *b*	,,	227	S	,,	C	$\frac{1}{2}$	$1\frac{3}{4}$	46		4	190 lbs.	266°	32°	336 lbs.	18	5	25
6 *a*	,,	220	S	,,	N	$\frac{1}{4}$	3	80·7	equal	$1\frac{1}{3}$	112 lbs.	246°	49°	311 lbs.		2 8	...
6 *b*	,,	220	S	,,	N	$\frac{3}{4}$	$1\frac{1}{4}$	60·4		$3\frac{1}{3}$	202 lbs	276°	22°	139 ibs.	25	3 8	35
9 *a*	,,	218	D	N	C	$\frac{3}{16}$	$3\frac{3}{4}$	$41\frac{1}{4}$	equal	6 6	...	255°	42°	460 lbs.	.	5·7	...
9 *b*	,,	218	D	J	C	,,	,,	$2\cdot\frac{1}{5}$		6·8	...	284°	14°	217 lbs.	31	8·1	41

small steam engines, but very little, if anything, has been done to render the rank and file of steam engines a credit to their makers. The early makers of large engines, such as the Low Moor Company, and, if we mistake not, Boulton & Watt, passed the working steam round the jackets on its way to the valves and cylinder. This looks odd at first, but probably was good practice.

The function of a jacket is to keep the cylinder hot and dry as far as possible. When the working steam passed round the cylinder it had the boiler behind it, and it stands to known facts that the jacket steam could not be colder than what was proper to its pressure. Now some of the steam in the jacket must have condensed. It therefore lost heat, but *did not lose temperature*. As it swept round the jacket space a centrifugal tendency would be developed, and the particles of water would be swept off the cylinder, and would be thrown upon the outer wall, down which the water would trickle to the drainage openings.

A double purpose was thus served; the cylinder was kept hot at the expense only of the *heat of evaporation* of such portion of it as condensed, and the steam was dried by the utilisation of the same principles that are now employed in the best water separators, cylinder condensation being thus transferred to the jacket, and the water *removed* from the chance of being re-evaporated. Where there is no separate higher pressure jacket boiler, we should much prefer the above old-time construction and working of steam jackets to the modern undrained and unventilated article, and we do not think we are going too far in pointing out the great improvement that might be effected in small engines by the use of the combined water separator and steam jacket, the very form of which lends itself so well to the double duty. This suggestion has the appearance of paying from one pocket into the other, and so it actually is. The merit, if there be such merit, as we anticipate, lies in the fact that the one pocket has a hole in it. It would be interesting to have so careful an experimenter as Mr. Donkin investigate the jacket on these lines.

THE HUNTING OF GOVERNED ENGINES.

By James Swinburne, M.Inst.C.E.

(*Read before Section G.*)

Lord Rayleigh pointed out some years ago* that the ordinary explanation of the action of the electromagnet in an electrically-driven tuning fork is incorrect, and that such a mechanism works in virtue of the self-induction of the electro-magnet. As far as the action of the contact goes, it is the same whether the leg of the fork is receding from the magnet or approaching it; and if the force depended only on the contact, and was symmetrical, no power would be supplied to the system. It would be like a pendulum which is acted upon by gravity equally whether the bob is going up or coming down. To make the pendulum work continuously, gravity would have to act more when the bob was coming down. As this cannot be arranged, a clock has to do the work instead. In the case of Lord Rayleigh's tuning fork, the magnet pulls harder when the leg is coming towards it than when receding, and thus gives power to the fork. In other words, the effect of the magnet lags, and thus becomes unsymmetrical. This is a most important principle, and it applies to a large number of varied cases of great importance, and of more interest to engineers than even electrically driven tuning forks. Broadly speaking, all kinds of continued vibration may be said to depend on this principle. Among these cases is that of the hunting of governed engines.

If a governor really behaved as it does in most text-books, and admitted steam in exact accordance with the speed of the engine, there would be no such hunting; but unfortunately a governor does not follow the variations of speed instantaneously. Apart altogether from questions of friction, or movement of heavy valve or expansion gears, many forms of governor, especially what may be described as the relay kind, alter the steam admission with some delay. The friction of the various parts and their tendency to remain in one position until the disturbing force comes up to a certain value, and to then move suddenly and overshoot the mark, increases this action. The result of this time lag in the action of governors is that in many cases engines, especially on light loads, get into a state of vibration known as hunting.

The orthodox way of treating such a subject would be to begin with the discussion of an engine with a fly-wheel and a frictionless governor with a dashpot or something of the sort, following a simple law. A system might thus be imagined which would fit a differential equation such as that used to find the current when an electrical condenser is discharged through an inductive circuit; and it might be possible to calculate the load which would just prevent permanent hunting, or any hunting at all. There are immense difficulties, however, for there are so many small causes of disturbance that such treatment would probably give no useful information. It may be best, therefore, to discuss the question verbally only, without expecting to arrive at very definite results.

When the load of an engine varies, for instance, by decreasing, if the steam supply remains the same, the extra energy goes to increasing the speed of the fly-wheel. Whether the speed of the engine follows the steam supply quickly or not thus depends on the fly-wheel. It also depends on the load. If a 1,000 horse-power is working at full load, and 900 horse-power is suddenly thrown off, and the governor does not act instantly, 900 horse-power is devoted to increasing the velocity of the fly-wheel, and unless the wheel has an enormous moment of inertia, or is turning very quickly, this power will increase its speed, say, 2 per cent. in a very short time. On the other hand, if the engine is only doing 100 horse-power, and this load is suddenly reduced to 10, there is only 90 to increase the speed of the fly-wheel, and to increase it 2 per cent. will take 10 times as long as in the former case. Putting the matter the other way, the engine obeys variations of steam supply more slowly at light loads, or, in other words, it obeys its governor more tardily at light loads. In practice many engines which run steadily at full load, hunt terribly when worked light.

Turn now to the governor. It is generally treated as complete in itself, without reference to the fly-wheel or engine load. A simple Watt governor, and most of the governors on small engines, have no appreciable time lag, except a certain sticking, due to friction, or to the absurd practice of putting a comparatively small governor to work direct on to a heavy expansion gear, or a stiff stuffing-box. These matters have been discussed in an able paper by Ransom* recently. There is not very much tendency to hunting with such governors. Their drawback is that as the steam must be nearly shut off at no load, and full on at full load, the valve gear must be in different positions, and the governor must therefore be in different positions too. This means that the engine will be governed at a considerably higher speed at light loads. To cure this the obvious course is to make the governor isochronous. The drawback to this is that an ordinary isochronous governor is not powerful enough if it has to move through a long range with a very small percentage of speed variation. It is likely to stick until the speed has varied a good deal, and then to move to its fullest extent. The result of this would be that the engine would be governed by having full steam and none at all alternately. I do not know why this method of governing should not be employed. If the governor works some light gear, such as the various modifications of the Corliss, this form of governor should work very well with a large fly-wheel. The cylinder would either get a charge of steam which would correspond to the full engine load, and which would, therefore, be expanded and worked in an economical way, or it would get none. This alternation of full load and no load is common in gas engines, and, for distinction, may be called the hit-and-miss method of governing. The only steam engine I know which employs it is the Parsons steam turbine. Of course, the great difficulty is the fly-wheel, especially in a slow-speed engine. If working at a tenth of its load it gets steam only every tenth revolution, and the fly-wheel must carry it round for nine. As high speeds are gradually coming in, it may be worth while to keep this method of government in mind, as it is most economical of steam, and as there is no time lag in the governor, there is no hunting.

Returning to the isochronous governor, the obvious method of overcoming the friction or weight of valve gear is to use some relay —to use a convenient electrical expression. The governor does not then act directly on the valve gear, but puts some screw or other mechanism into gear, which works the expansion or throttle valve. Willans used a water relay. The governor worked a minute water valve, controlling a cylinder which worked the throttle valve. Such an arrangement can be made very accurate, as a very small movement of the governor, opposed by a very slight force, can be made to work the most obstinate valve gear. But we have at once danger from hunting, as there is considerable time lag in the governor. Suppose the load is suddenly decreased, the engine speeds up and the governor begins to increase the expansion, but effects this slowly, and by the time the valves are right for the reduced load, the engine is much above speed. The governor, therefore, goes on reducing the steam until the engine has far too little. It, therefore, slows down again. But the governor continues reducing the steam until the engine is slowed down to its normal speed. By that time the engine has far too little steam, so it goes on falling in speed. The governor then begins to turn on steam again, but it does it so slowly that the engine has fallen far below speed before the normal steam supply is given, and the governor goes on turning up steam till the engine arrives at its normal speed, when it has far too much steam, and is again rapidly increasing in speed. This cycle of operations is repeated over and over again. It depends on the lag of the governor, the fly-wheel, and the load, whether the hunting is temporary, so that the variations of speed are less and less every time; or permanent, in which case the engine alternates between no steam and, perhaps, full supply. An engine which hunts permanently at very light loads often works perfectly over half-load.

An ordinary governor is thus apt to be insensitive and to allow the speed to vary with the load if designed not to hunt; and if arranged to work a relay, hunting results. An isochronous governor with a dashpot has, of course, a time lag too.

It is easy to make a governor which combines the advantages of both systems, and avoids the drawbacks.

A governor made by Messrs. Weyher, Richmond & Co., of Pontin, may be cited as a good example. It is not isochronous, and it works directly on the steam control. I may mention that even in small engines the French arrange the valve gear so that it is very easily controlled. The variable detent is very common. In addition to working the steam control direct, any movement of the balls from the normal position puts a screw gear into motion, which slowly alters the intermediate gear, so that the engine finally runs at the normal speed, whatever the load is. It is unnecessary to describe the particular gear employed; a typical case may be imagined. Suppose the expansion link is in connection with the middle of a lever, and the governor with one end, A, the other end, B, being fixed; an increase of speed raises the end, A, of the lever and the middle, and you have an ordinary non-isochronous governor which gives a higher speed at light loads. Suppose, however, that any rise of the end, A, of the lever sets a train to work which slowly raises the other end, it will go on till the governor is in its normal position. We thus get a governor which does not hunt and gives the same speed at all loads. If the valve gear is heavy or stiff, the governor may work one end of the lever by means of a relay, but it must be a following relay, such as those employed in steam steering gear, so that the

* Royal Institution, March 15th, 1878.

* *Proceedings* of the Institution of Civil Engineers, Vol. cxiii., page 194.

extent as well as the direction of the movement of the governor end of the lever is controlled by the position of the governor; and this gear should act as promptly as possible to avoid hunting. The other or relay gear then works slowly. In such a governor it will be seen that the end, A, of the lever eventually comes to its normal position in all cases, and only moves to counteract sudden variations of speed. The real control is effected by the slow-moving relay moving the other end, B.

Instead of using one governor, a pair may be employed, one of which works direct on the valve gear, and the other by means of a slow-working relay. This method does not seem so simple as using a simple governor to do both.

These matters must have been worked out thoroughly by many engineers, and they appear so simple that one almost feels ashamed to bring them forward here; but in looking the matter up I find the governor is generally treated by itself, without reference to the engine. I have, therefore, thought it might be worth while to bring this subject forward, and trust you will bear with me for having put it in such a very elementary manner.

A SPECIAL CHRONOGRAPH.

By Henry Lea, M.Inst.C.E., and Robert Bragge.

(*Read before Section G, August 13th.*)

In his capacity as electric inspector for the City of Birmingham the duty of one of the writers is to test the accuracy of the electric meters used in that city. The test involves an accurate measurement, on the one hand, of the current of electricity passing through the meter, and on the other hand of the period of time during which the current of electricity effects a certain number of revolutions of the meter armature.

For the electrical measurements he selected a Crompton potentiometer, but as his chronograph was not accurate enough, he drew up a specification upon which the English Watch Company built the chronograph exhibited to the meeting. The ideal chronograph is one with a perfectly divided dial, an absolute prompt start, a definite stop at zero, and a continuous or running motion of the hand.

The test-room chronograph under notice is not intended for use as a watch; it is purely and simply a micrometer applied to time, and therefore it has only two pointers—one from the centre, giving seconds and their fractions, the other placed halfway between the centre and circumference, showing minutes up to sixty. The dial of aluminium, being engine divided, is mechanically perfect; and being of large size, 2½ inches of sight, the divisions of ten to the second are clearly defined.

The prompt, absolute start is obtained by dispensing with all intermediate gearing and relying on the main train of wheels impelled by the ordinary mainspring. The starting lever not only releases the balance-wheel, but at the same time by the momentary contact of a light spring blade impels the wheel in the required direction.

The absolute stop at the end of an observation is obtained by the frictional contact of the aforesaid spring blade with the edge of the balance-wheel.

The absolute stop at zero is obtained by fixing upon the axis of the seconds wheel a collet carrying a blade. Upon the top of the movement there is a lever, which, during the period of an observation, is held back; but when the observation is concluded it is set free by a push of the button, and falls to a point where it crosses the path of the blade already referred to, and stopping the wheels brings about the absolute stop we require.

The last thing requisite is for the seconds hand to have a continuous run. Everything tried up to the present has had a tendency to accelerate its rate, and is therefore inadmissible. The lever escapement has been adhered to, and by using hard stone jewellings, and by observing great accuracy in the angles of the pallets, the makers are enabled to double the ordinary number of beats—36,000 instead of 18,000—and although in every beat there are three processes, the whole follow so smoothly that the progression of the hand is practically continuous.

ON STANDARDS OF LOW ELECTRICAL RESISTANCE.

By Prof. J. V. Jones, F.R.S.

(*Read before Section A, Tuesday, August 14th.*)

With the help of his assistant, Mr. Harrison, the author has been for some time engaged in preparing standards of low electrical resistance. The form of standard presented to the section in his opinion, adequately fulfils all requirements, and may be advantageously adopted for resistances of from ·001 to ·0001 where the accuracy aimed at is 1 part in 10,000.

Such standard must in practice be realised, as the resistance between equi-potential surfaces passing through two points of a conductor conveying a current. It will, therefore, have four terminals for the attachment of external conductors, viz., two current terminals for the entrance and exit of the current and two potential terminals for the wires from the voltmeter.

The following conditions must be fulfilled:—

(1.) The shape of the equi-potential surfaces in that part of the conductor which is near and between the potential terminals must to the degree of accuracy aimed at, be independent of the particular point or points of the current terminals at which the cables make contact.

(2.) The difference of potential between the potential terminals must to the degree of accuracy aimed at, be independent of the particular point or points on them at which the voltmeter wires make contact.

(3.) The resistance should be capable of satisfactory and easy adjustment.

(4.) The instrument should be of such dimensions and made of such material as to be capable of taking a large current without too great a change of resistance due to heating.

The standard shown by the author has a resistance of about ·0005 ohms, and will take a current of 50 ampères without changing its resistance more than 3 parts in 10,000.

A detailed description, with drawings, will be published in the near future.

WOODHOUSE & RAWSON UNITED, LIMITED.

Mr. F. L. Rawson's Statement.

On Thursday last, August 16th, Mr. F. L. Rawson, the managing director, attended at Bankruptcy Buildings before Mr. Registrar Hood, and put in a written statement dealing with the points that had been raised during the examination. He was asked no questions by the Official Receiver upon it, and stated that he would like to thank the Official Receiver for the kindness he had shown since he found nothing unsatisfactory with regard to himself, and also stated that he would like to give his views with regard to the great assistance that a public examination was to the directors, and especially to himself personally, in getting matters cleared up. He further said that he would like to apply to the Court for payment of his out-of-pocket expenses, and was told by the Registrar that he would have to make special application for them.

His statement consisted of 129 pages of type-written foolscap, together with a large number of appendices, being letters, documents, &c., in proof of his statements. He first dealt with the suggestion that the profits in 1890 were exceptional, by giving instances of future transactions that the company had had of the same class. He then dealt with the return of the £75,000 guarantee fund, and showed that at the date at which this was returned, no further profits had been made. The directors estimated that the dividends of 15 per cent. for the remainder of the guarantee term would amount to £48,129, whereas the surplus of the profits the first year, which had to be deducted, amounted to £42,335; this only left £5,694 to be paid out of the guarantee fund, whereas Woodhouse & Rawson United actually only returned £63,000, and therefore in any case were gainers of some £6,000 by the transaction. It astonished him that anyone who pretended to understand anything about figures could try to attack the directors for this return. If the guarantee fund had not been returned, as a matter of fact the whole £75,000 at the end of the term would have had to be returned, and either securities would have been handed up at a discount, or what is more likely, Woodhouse and Rawson, Limited, would have given time to the United Company to repay the money, taking a charge upon the uncalled capital, and, therefore, neither the debenture holders, the creditors, or the shareholders are prejudiced by the return in 1891, but the reverse. He went fully into the position of the company at the date of the return fund, giving details of the bright prospects of the company, and stated that at the end of this year, when the last dividend was paid, matters had not materially changed. He gave 23 instances intended in proof thereof. He stated that although there was an increase in the amount of securities held for the previous year, he did not think the board were too sanguine as to the prospects of selling them, as in the previous year they had sold £116,625 worth, and the first year £56,170 worth. The total amount of shares and debentures sold by the company came to £185,298, realising £207,175, distributed over 13 different securities. He then gave particulars with regard to the position of the Okonite and Epstein Companies, also Elmore, Phœnix, Ward Car, and other securities held, and stated that the year of the payment of the last dividend three gentlemen were appointed to examine investments on behalf of the other shareholders, and two of them went carefully into them and were satisfied; further, he stated that they always gave full particulars of the investments to shareholders who called to see them. With regard to these securities, nearly all of which were quoted, he stated that they never put them in at more than Stock Exchange quoted prices, and in two cases put them in below; where they were unquoted he gave instances of the care taken by the directors in their valuations, and put in correspondence showing what had been done. As showing the break-up prices that the directors had put in their statement of affairs, he instanced the Sociedad Barcelona shares which were put in as estimated to realise 10s. per share, whereas a recent careful valuation by the company, which is the Electric Lighting Company at Barcelona, shows that the selling price of the tangible assets, such as land, buildings and machinery, would realise an amount equal to about £2 10s. per share. With regard to the valuations of stock and plant, he put in correspondence between himself and the managers, showing how he insisted upon having the plant and stock written down to its lowest point. The year after he had assured the shareholders that he would always see that this was properly done, he had the major portion of the stock gone through by Messrs. Wheatley Kirk, Price & Goulty, and by their advice further wrote down the stock some 3 per cent. in value. He also put in correspondence between Sir Rawson Rawson and the head of the industrial branches, showing that Sir Rawson Rawson personally looked into this matter himself most carefully. With regard to the only industrial valuation that had been challenged, namely, the valuation of Kidsgrove, and that by Mr. Stutchbury, he showed that the plant and stock were most carefully valued, and with regard to what was called the "over-

valuation" of £2,600, in 1891, this was owing to the extreme care taken the previous year, when although the valuation came out £3,600 above what was expected, they only credited £1,000, waiting until the valuation was again taken the following year before they took credit for the extra £2,600, the valuation the first year having been formed by that of the following year. He then gave seventeen instances of statements made by Mr. Stutchbury in the course of his examination that he (Mr. Rawson) asserted were not correct, and there accompanied these statements evidence as proof that they were incorrect. Mr. Rawson dealt with Mr. Stutchbury's analysis of the trading of 1890 and 1891, and showed a considerable number of errors in same. Mr. Rawson stated that in the year 1890, whilst he had charge of the industrial business every department showed a profit but the contract department, which the following year, however, nearly doubled its turn-over. He showed, from extracts of the shareholders' meeting, that the shareholders were not misled as to the questions of the profits having been made from the financial business, and stated that the turn-over of the third year was double that of the first. He then dealt with the auditor's (Mr. Pixley) remarks, drawing attention to the point that Mr. Pixley had stated that the accounts would not be correct if the shares in 1891 had not been valued. Mr. Pixley had admitted that it would not do to purposely under-estimate the value of these shares, as it would merely be on the safe side, and relieve the directors of responsibility, as if the following year had been as good a year as was expected, the increase in the value of the shares then under-estimated would have increased his (Mr. Rawson's) remuneration by 25 per cent. of the amount of the under-valuation. He quoted a remark of Mr. Pixley's to him in that year, which was to the effect that he (Mr. Pixley) considered it his duty just as much to protect the directors as to see to the shareholders. If any difficulties in the future should arise, the directors would be most grateful to him for the care he had taken and for the amount that had been written off. The amount he gave as being written off, according to Mr. Pixley's advice, was £9,000. He also said that Mr. Pixley did not ultimately object to the payment of the final dividend, but wanted a smaller dividend paid. This was after Mr. Pixley had seen the care with which the directors had made their valuations, and after they had taken Mr. Pixley's advice as to writing down. He (Mr. Rawson) stated that in a company such as Woodhouse & Rawson United, he saw no difference between profits represented by securities or by stock; that, in fact, profits, if they were securities in companies that are intrinsically sound, were better than those represented by plant or stock; the former appreciating and the latter depreciating by time. He drew attention to the large amount to reserve after the payment of the last dividend, namely, £46,996, and he stated that if they had taken credit, as they were entitled to, at quoted prices for some of the shares, the value of which they had reduced; and if they had taken credit for certain items as they were allowed to by the articles of association, the amount of this reserve would have been increased to £63,263; whereas if the shares in the Phœnix Trust and the Epstein Companies had been valued at Mr. Stutchbury's cost price estimate, and the value of the unquoted securities were taken at break-up prices, these would still leave a balance at reserve, after paying the dividends, of £17,296, or £36,602 if the additional amounts above mentioned were included.

(To be continued.)

FRENCH SUBMARINE CABLES.

Our attention has been drawn to a "brochure" of some 40 pages, published anonymously in Paris, which criticises very severely the proposed amalgamation between the Compagnie Française du Télégraphe de Paris à New York and the Société Française des Télégraphes Sous-marins, or rather the absorption of the former unfortunate company by the no more fortunate latter—a procedure which the author considers would be by no means advantageous to the former.

The history of the Société Française des Télégraphes Sous-marins is thus briefly given: A certain Count d'Oksza, of foreign origin, but a naturalised Frenchman, acquired some telegraph lines in Central America, and purchased the exclusive landing rights for submarine telegraph cables in Venezuela, Haiti and San Domingo. He afterwards sold these rights to a group of financiers who floated the company. The new company at once commenced negotiations with M. Granet, Minister of Posts and Telegraphs, and in 1886 an agreement was signed between them embodying the conditions under which a line of cable from Brazil to New York *viâ* Cayenne, Puerto Plata and the French West Indian Islands was to be established. Unfortunately the Chamber of Deputies refused to ratify this agreement, and the French company abandoned a great part of their scheme and contented themselves with establishing certain cables between the West Indies and Brazil, for which they obtained local guarantees of traffic amounting to 260,000 francs (say £10,400) a year. The cables were made partly in England, and partly at the works of the Société Générale des Téléphones at Calais, and were all laid by English engineers. Thus their system of some 3,754 miles came into existence between 1888 and 1891, at a cost stated at 18,000,000 francs (£714,000).

The Compagnie du Télégraphe de Paris à New York was founded in 1879, with a capital of 42,000,000 francs, and in the following year their cable from Brest to St. Pierre, with three branches, a total of 3,495 miles, was opened for traffic. These cables were laid by Messrs. Siemens Brothers for the sum of 33,908,000 francs (£1,345,000), in which price was also included the repairing steamer, *Pouyer-Quertier*, completely equipped. The company made a bad start, and in a few months were very glad to join the pooled English Companies under a joint purse arrangement, by which they received 16 per cent. of the total traffic—about four times as much as they would otherwise have succeeded in getting. This arrangement was come to without the written consent of the French Government, however, and in 1886 when the Commercial Cable Company became large shareholders in the "P. Q." Company, a new board of directors was elected, and their first act was to repudiate the joint purse arrangement entered into by their predecessors. This led to a lengthy lawsuit with the allied English Companies, which was only recently decided against the French on all points, and which will cost them many thousands of pounds.

The author of the brochure goes on to give long details of what he states to be gross mismanagement on the part of the directors of both the companies who propose to amalgamate, and points out the wretched financial condition they both are in. If these anonymous statements are true, it certainly is difficult to see what possible advantage can result to either company from their amalgamation.

CORRESPONDENCE.

Electric Lighting Contracts and Professional Advice.

Your correspondents, "Consulting Engineer" and "Professional," have agreed that consulting engineers who are dependent upon consulting work only for their existence should be protected in some way from the piracy of those who, while having other means of making an income, do not hesitate to palm themselves off as consultants whenever the opportunity arises. There are, however, two points requiring very careful consideration at the outset. In the first place why should consulting engineers require protection from the contractors who occasionally act as consulting engineers to a greater degree than the contractor, pure and simple, from consulting engineers who do not hesitate to act as agents for manufacturing firms or are even manufacturers themselves? In the second place, supposing that it be agreed that some definite status should be given to the consulting engineer who prefers to maintain his position as a *bona fide* consultant, the problem arises, how can a body of men, fallible in themselves, protect their interests from those who would possess the power of entering such a coterie?

It is evident that the sole reason why consultants require some protection at the present time is the small amount of genuine consulting work which presents itself. When this already small amount is diminished by "Consulting Engineers, Limited," and by men who are at times contractors, at others consultants, the little becomes less, and the professional man is tempted to do as his neighbour does, and make ends meet by similar practices. This is much to be regretted and strongly to be condemned. Take, for instance, the recent action of the Institute of Chemistry, which has had occasion to deal with the ethics of consulting chemistry. There the recognised and leading body of the profession has seen fit to touch a delicate question, and to point out in no uncertain manner that the unwritten code of laws by which professional etiquette is governed may not be infringed with impunity. The professional man cannot protect himself as an individual; here he is at a disadvantage compared with the contractor. The latter may advertise, may canvass and utilise the columns of the press to air his grievances; the other cannot do so without risking, to some extent, at least, his reputation, and laying himself open to the imputation of a breach of confidence. If, therefore, action is feasible in any direction, it certainly remains for the representative body concerned with matters engineering—the Institution of Civil Engineers—to see if some professional status could not be given to *bona fide* consulting engineers, by which they might be distinguished from those who have not sacrificed the profits accruing from work in other branches to follow this particular sphere of labour in the engineering world.

When such a matter comes up for discussion it would be well for some attention to be given to the history of the Chartered Institute of Patent Agents. The career of stock-brokers in the House, and those "outside," also might be compared, and would furnish analogies of some utility. At the same time, the common instances which occur to one's mind when discussing this question are those of members of the medical, legal, and clerical professions, who may not practice in the same without a diploma or certificate of their

assumed fitness so to do. An engineer must have gone through a course of practical training to be competent to act as a consultant, otherwise a solution of the difficulty would be to limit the professional side to those who possessed a degree in engineering from a college or university. This, however, as at present arranged, would hardly meet the case.

Charles H. Yeaman.

Portable Batteries.

The designing and manufacture of portable batteries has latterly, for the most part, fallen into incompetent hands. A competitive trial of these appliances, carried out under scientific and professional supervision would, I think, be productive of much good. It would enable the ignorant public, including the directors of certain companies, to distinguish between apparatus made to sell—though not necessarily for sale—and other instruments devised with great care, and based upon the results of an immense amount of experimental work.

I have been led to these remarks by the letter of Mr. A. W. Bennett in your last issue. Unfortunately, the preceding number of the REVIEW did not reach me, so that I have not the whole subject-matter before me. It appears to be a question of a current required intermittently for a few minutes at a time, during which period it must be nearly constant. Mr. Bennett is very naturally sceptical as to the existence of a battery which, with a weight not exceeding 4 lbs., will maintain an output of 12 watts even for short periods. Such a battery is, I think, readily attainable; it should, of course, be specially designed for the object in view. I do not at the present moment happen to have one that is suitable, but I have now before me two little so-called "dry" or solid batteries, each of two cells, and each working a 4-volt lamp taking about half an ampère. Battery *a*, in a solid ebonite cell, weighs less than three-quarters of a pound. Battery *b* weighs one pound and a half. Being, as I have said, "dry" cells, they are not, apparently, very well adapted for heating platinum wire; nevertheless, an experiment with them may be of interest. All "portable" cells, by the way, should be of the dry form.

My platinum wire is 10 mils. in diameter, *i.e.*, No. 33 S.W.G. I find that battery *a*, with the cells in parallel, will maintain three-quarters of an inch of this wire at a red heat. It does this again and again, for one minute at a time, at intervals of five minutes. I then put it back to its work on the 4-volt lamp, having first connected the cells in series. Probably the little battery would soon break down if kept on the platinum circuit; this I will admit, as I do not want to overwork it just now.

Battery *b*, with cells in parallel, heated to redness an inch and a half of the wire, with the two cells in series, the length was $2\frac{1}{4}$ inches.

I quote these results, not because they embody a conclusive experiment, but because many who are not *au courant* with the real progress made in the construction of portable batteries might well have doubted the power of these to heat to redness even half an inch of the wire specified, and also because we may infer from them that, within the weight of 4 lbs., a battery could certainly be constructed which would give an output of 12 watts, at intervals, for many periods of a few minutes.

Desmond C. FitzGerald.

Synchronous Photograph taken at Portsmouth.

At this station the effect has been observed, and experiments made to ascertain whether it did exist when incandescent lamps only were used. For some time we were unable to get any but a negative result until a lamp having a quick-cooling filament was used, when we succeeded in reproducing the effect on a more feeble scale.

It is interesting to endeavour to calculate the self-induction between dynamo and lamp when this effect is observed.

John Hesketh,
Borough Electrical Engineer, Blackpool.

Electrical Distribution by Alternating Currents.

I regret that, owing to the holidays, I did not see Mr. Faber's letter in time to reply to him in your last number. I am entirely at issue with the opinion he has expressed respecting my controller switch, and he is in error in supposing I had patented an invention without having previously tested and proved it. My system is as to its several parts, and, as a whole, the outcome of practical work. I fear that Mr. Faber has not understood my specifications.

W. Lowrie.

NOTES.

Italy and the Telephone Service.—The Italian Minister of Posts and Telegraphs has decided to send an inspector to Germany to study and report upon the organisation of the telephone service in that country.

A New Amalgamation.—Mr. Henry Gordon Stott, electrical engineer, of the Buffalo General Electric Company, Buffalo, N.Y., was married on July 23rd to Miss Anna Mitchell, daughter of John K. Mitchell, of Belfast, Ireland. Mr. Stott has been some time in Buffalo, and was at one period electrician on board the cable-laying steamer *Minia*.

The Building of the Ship.—The resistance of canal boats to traction has been investigated for the Ministry of Public Works of France by M. De Mas. It was found that at a speed of 3·28 feet a second the resistance of the 70 odd types of barges ranged anywhere from 3 to 8 lbs. per square foot of immersed section. If the resistance at a speed of 5 feet a second with a draught of 3·28 feet (1 metre) is called unity, the resistance with a depth of 4·27 feet (1·3 metres) becomes 1·13, and with a draught 5·25 feet (1·6 metres) becomes 1·27. That is to say, the resistance does increase with the displacement of the boat, but more slowly. Another fact found out was that the resistance may be much reduced by using smooth surfaces below the water line, the total resistance of a wooden barge being diminished from 782 to 551 lbs. by covering the sides with oilcloth. The length of the boat was found to have little influence on the traction when the speed was 5 feet or more a second, but the form of bow and stern was shown to be important, a spoon-shaped bow giving the best results. Electric launch builders may take a hint from the oilcloth experiment, as might possibly the builders of the Atlantic "Greyhounds," whose chief and most important mission on the ocean seems to be the beating of records.

Breaking the Record.—The final splice of the Anglo-American Telegraph Company's new cable was made at 11 a.m., Greenwich time, July 27th, and the laying of the largest cable across the Atlantic was then successfully completed. The time taken, says the *Scientific American*, in laying the new cable was the shortest on record. The expedition left Heart's Content, N.F., on July 15th, in the afternoon, and the final splice was made on the morning of the 27th, or less than 12 days. As the Irish shore end was laid in less than two days, the total time taken was inside of two weeks, a most remarkable achievement when it is considered that this cable is of the heaviest type ever laid. A curious coincidence in connection with its completion is the fact that the final splice was made on the anniversary of the day on which the first successful cable was landed at Heart's Content in 1866, 28 years ago, and not only the same date, but on the same day of the week. The new cable is laid between Heart's Content and Valentia, Ireland. This cable has a larger conductor than any cable ever laid. It contains 600 pounds of copper per nautical mile. This increase of copper in the conductor means a proportionate increase in the speed of transmission. The new cable has, therefore, the greatest capacity of all long cables. It is consequently a valuable addition to the telegraph facilities between America and Europe. Both the new "Atlantics" were the theme of a special article in the 27th July issue of the ELECTRICAL REVIEW.

An Atlantic Cable Line.—A Dalziel's telegram from Paris, dated 21st, states that it is rumoured there that negotiations are pending between the French Atlantic Cable Company and one of the largest of the English Telegraph and Cable systems for an amalgamation.

A Sad Accident.—A New York contemporary states that Mr. C. H. Rudd, one of the electrical staff of the Western Electric Company, has been experimenting lately in the vicinity of Chicago with a new explosive, whose action is said to be based on the sudden generation of heat electrically. On July 31st an explosion occurred at his works, when three of his assistants were killed, and he and two other persons were badly injured.

Rollason's Wind Motor.—Last Monday a number of ladies and gentlemen assembled at Winchester House at a meeting of Rollason's Wind Motor Company, Limited, but we have no idea what the business done was, as representatives of the press were informed that the proceedings were private. It will be remembered that there was recently at Willesden a press inspection of the Windmill. A descrip- of same, and our opinion regarding it, were given in the Electrical Review for April 20th last.

The Heilmann Electric Locomotive.—The Western Railway Company (France), being satisfied with the results obtained at the trials of the Heilmann electric locomotive, has just ordered two more locomotives to be constructed, in which certain alterations will be made with regard to the boiler and the steam engine. This latter will be a Willans engine of the 1,500 horse-power type, this model having been selected on account of its possessing great strength, joined to lightness of construction, and, at the same time, working both well and economically.

Oh! Kafoozelum.—One does not often read of such eminent men as Lord Kelvin, Lord Wolseley, Sir Evelyn Wood, Sir John Pender, Sir J. Adagh, and Lord Portsmouth having a "donkey ride," but the *Standard* Athens correspondent states that these gentlemen made an excursion from the town of Syra, the other day, mounted on donkeys, and, of course, attracted much attention. It was doubtless due to force of circumstances, that the principal living representative of the world's telegraph system and the most notable scientist of the day, chose this exceedingly rapid mode of travelling.

English as She is Wrote.—Another instance of the manner in which the English language is mutilated by foreign translators, appears in a circular of incandescent lamps hailing apparently from some German town. The following are two extracts from the circular referred to :—

Our incandescent lamps remarkable for their excellent quality have by proper use approximate life of about 1,000 hours and are pre-eminently economisers of the electric stream.

Wherever the electric stream is very expensive *or must be paid for*, we can recommend our stream economising lamps, which have it is true life for only 500 hours but when compared with the usual incandescent lamps it consumes 30 per cent. less electric stream and is consequertly 30 per cent. cheaper.

Special prospectus for dynamos with egualid and changeable stream.

Gas v. Electricity in Germany.—The decreased consumption of gas in Berlin has led the Corporation to investigate the cause, and collate voluminous statistics. The following are stated to be the principal reasons for the diminished consumption :—The growth of electric lighting, more general use of petroleum, increased adoption of gas-saving appliances of various kinds, the "Sunday Rest Act," and the depression in trade and industry. There need be little doubt that of all these, electric lighting is the most powerful opponent, and as it comes to be used more extensively, which it inevitably must, gas in consequence will feel the fight even more keenly. Gas interests on the Continent appear to be more injured at present by the growth of electric lighting than those of this country, but this is accounted for by the fact that electric lighting interests here are younger than in Germany. In the Electrical Review for February 19th, 1892, a foreign correspondent went into the comparative figures in detail, and it is doubtless owing to the state of things that then existed having become worse, that the Berlin authorities caused investigations to be made.

Electric Power.—At the renewed sittings of the members of the Iron and Steel Institute at Brussels last Monday, the papers included one by Mr. D. Selby Bigge on "Electric Power."

Erratum.—In the article published in our issue of the 10th inst., "The Lighting of Public Streets, and the Cost," on page 162, the word "arc" should be "are." The are is the unit of surface for land measurements :

1 are = 100 square metres.

Testing of Lightning Conductors.—An Indian contemporary states that a special feature in the report on lighthouses in Burma during the past year was the attention paid to testing the lightning conductors attached to lighthouses and light-vessels. Periodical visits are arranged by officers of the Telegraph Department, whose results are carefully checked by the head of the department.

A London-Berlin Telephone.—It has been decided by the Belgian Government to open negotiations with the British Government for the construction of direct telephone communication from London to Brussels *via* Ostend, it being understood that should the negotiations be successful the authorities at Berlin have signified their willingness to consent to a connecting telephone line from Brussels to Berlin. It is thus highly probable that before long London will be in direct telephone communication with Berlin.

"Punch's" Telephone.—In a short article on "The Next War," published in this week's *Punch*, the writer, in his attempt at smartness, has overstepped the mark, and made a very laughable error. A successful general refuses the press any details of a great victory until he has sent a telephone message to a certain stock-broker, and, according to the writer, "Suddenly applying his lips to the receiver and ringing up," he asks for No. 7. Time was when the Bell telephone acted in the dual capacity of transmitter and receiver, but surely *Punch* has not been keeping back its contributor's article for the last fourteen years for the purpose of making *Fun* now ?

Interruptions in Submarine Cables.—Considering the enormous length of submarine telegraph cables now in existence, it is certainly a remarkable thing that it should sometimes happen, as it has recently, that no single section upon which communication with any part entirely depends should be interrupted. When this is the case it does not necessarily mean that every cable throughout the world is working ; a great many are duplicated, or even triplicated, and a break in one of these, since it does not entirely prevent communication, need not be notified to Berne, and so never gets to the knowledge of the public.

Dangers of High Pressure.—At equal pressures the continuous current is more destructive to life than the alternating current, as explained by Prof. S. P. Thompson ; but more deaths have been caused by the alternating current. Men have recovered from an alternating shock from a 2,000-volt circuit, but no instance of recovery from a continuous current shock of such voltage has, so far as we can recollect, ever been known. A 2,000-volt arc circuit is most deadly ; a continuous current paralyses the victim instantly, while an alternating shock usually causes the subject to jump or throw himself up or back, thus sometimes saving himself.

Gassner Dry Cell.—As the subject of dry batteries is a matter of considerable interest, we give an example of the powers of Dr. Gassner's dry cell, which is controlled in this country by Messrs. Hodges & Todd, who inform us that these are unsurpassed for duration, efficiency, and general finish, and as an instance of what an ordinary cell, $6\frac{3}{4}$ inches by $3\frac{1}{4}$ inches diameter, has done, they placed one of these in circuit with a 3-inch trembling bell, taken at random from stock, which it continued ringing without intermission for over 750 hours. This same cell, after a short interval, was again put in circuit with the bell, which it rang for 105 hours without ceasing, and for three consecutive times it has continued ringing this bell for over 55 hours at a stretch after short intervals of rest, and at the present time it is not exhausted.

Sudden Death.—An engine driver employed at the Woking Electric Lighting Company's works fell dead last week while carrying out his duties. The cause is stated to be heart disease, no symptoms of death from electric shock being observed.

"The Pall Mall Gazette."—It is stated that during the past 12 months Mr. Astor has lost £40,000 over the *Pall Mall Gazette*. Doubtless certain medical electricians will consider this most delightful news.

New Portable Electric Light.—The daily papers say that military circles in Germany are taking a deep interest in a new portable electric light. Accumulators can now, so they say, be produced of only half a German pound in weight, so that every soldier can carry one in his pocket. Newspaper men, as is their wont, have made quite a sensation over this by no means remarkable result, but Mr. Desmond FitzGerald can probably go one better with a primary battery.

Taunton Boys and the Arc Lamp Globes.—Some naughty boys are having sport at the expense of the electric arc lamp globes at Taunton, by "shooting" their catapults at them. £1 reward has been offered for the capture of the offenders.

Steam Engine Governors.—Mr. James Swinburne, with the characteristic modesty which so becomes his extraordinary gifts, apologised for bringing his paper on "The Hunting of Governed Engines," before Section G. of the British Association, on the ground that the matters to which he drew attention were so simple that they must have been thoroughly worked out. We are of opinion, however, that Mr. Swinburne's paper will be of the greatest possible value to engineering students, if not, indeed, to many engineers who consider themselves fully fledged.

"La Lumière Electrique."—We regret to learn that the directors of this journal have been compelled to suspend its publication for a short time, owing to its having been run at a considerable loss. We hope it will not be long ere they are able to get sufficient funds together to enable them to resume publication. In a circular lately sent out they state their decision not to endeavour to run *La Lumière* with advertisements, as it is desirable to continue it as a journal of pure science, unconnected with commercial matters.

NEW COMPANIES REGISTERED.

Edmondson Electricity Meter Syndicate, Limited (41,756).—This company was registered on the 10th inst. with a capital of £2,000 in £1 shares, to acquire the patent for the manufacture of electricity meters, invented and patented by Joseph Edmondson, of Bradford, Yorks, electrical engineer, and to deal in electricity meters and all apparatus. The subscribers (with one share each) are:—J. Edmondson, Heath Avenue, Halifax, electrician; E. Edmondson, Heath Avenue, Halifax, married woman; F. Priestman, J.P., Pierrement, Bradford; M. Priestman, Pierrement, Bradford, married woman; E. Priestman, Moorfield, Bradford, manufacturer; H. E. Priestman, Moorfield, Bradford, married woman; J. Cooper, Ilkley, top maker. Registered without articles of association by Waterlow & Sons, Limited, London Wall, E.C.

Ariel Arc Lamp Syndicate, Limited (41,784).—This company was registered on the 16th inst. with a capital of £20,200 in £10 shares, to adopt a certain agreement, and to carry on the businesses of electricians, suppliers of electricity, and manufacturers of and dealers in all apparatus capable of being used in connection with the generation, distribution, supply, accumulation, and employment of electricity. The subscribers (with one share each) are:—H. F. E. Capper, 5, New Inn, W.C., solicitor; W. G. Lloyd, 61, Holland Road, W., gentleman; A. Pollock, 36, Curzon Street, W., solicitor; A. E. Sanderson, Camden Square, N.W., solicitor's clerk; A. H. Bellingham, 61, Lincoln's Inn Fields, W.C., solicitor's clerk; A. F. Willoughby, 93, Park Street, W., solicitor; M. Gwynne-Griffith, 63, Lincoln's Inn Fields, W.C., solicitor. The first directors are S. S. Allin and C. S. G. Lloyd; qualification, £500; remuneration not yet determined. Registered by M. Gwynne-Griffith, 63, Lincoln's Inn Fields, W.C.

OFFICIAL RETURNS OF ELECTRICAL COMPANIES.

London and Hampstead Battery Company, Limited (36,425).—This company has filed its yearly return, which shows that out of a nominal capital of £50,000, in 7,000 preference and 3,000 deferred shares, all of £5 each, 615 preference and the whole of the deferred shares have been taken up. There has been £5 called on each of 249 shares, and £3 10s. on each of 366 shares; £2,170 has been received, £15,000 has been agreed to be considered as paid, and £356 is yet outstanding.

New Zealand Electrical Syndicate, Limited (33,003).—This company's yearly return, filed on June 29th last, shows that out of a nominal capital of £30,000 in £10 shares, 2,955 shares have been taken up, and that the full amount has been called on 955 of these. A sum of £8,040 has been received, £20,000 has been agreed to be considered as paid, and £1,510 is still outstanding.

Ateliers Hoster de Saint Nicolas, Limited (33,057).—The Inspector-General in Companies Liquidation, writes the Registrar of Joint Stock Companies, that the Board of Trade have, by an order dated June 4th, 1894, granted the release of Mr. C. J. Stewart as liquidator to the above-named company.

Bishop's Stortford Electric Light and Steam Laundry Company, Limited (31,565).—The late hon. secretary, Mr. J. H. Findlay, writes the Registrar of Joint Stock Companies that the above concern, owing to inability to obtain capital, has never done any business.

Reuter's Telegram Company, Limited (1,909 C).—This company's yearly return, filed on the 17th ult., shows that out of a nominal capital of £100,000 in £8 shares, 11,839 shares have been taken up, and that the full amount has been called and paid on each.

Head, Wrighton & Co., Limited (31,754).—This company has filed its yearly return, which shows that out of a nominal capital of £210,000, in £5 shares, the whole of these shares have been taken up, called, and fully paid.

Allen, Everitt & Sons, Limited (31,632).—The registered office of this company is now at Kingston Metal Works, Smethwick, near Birmingham.

Blakey, Emmott & Co., Limited (23,120).—The registered office of this company is now at Prudential Buildings, Park Row, Leeds, Yorks.

BUSINESS NOTICES, &c.

Electric Lighting in Islington.—A special committee have made exhaustive enquiries as to the relative cost of gas and electricity, especially with regard to street lighting. They report that they have been unable to obtain any definite data from actual experience of the relative cost of lighting public streets by gas and electricity. Very little street lighting has, up to the present time, been carried out by local authorities (many of whom own the gas-works), but there are indications of rapid advances being made in this direction, notably at Blackpool, Brighton, Dublin, Hanley, Preston, Tunbridge Wells, and St. Pancras. In nearly every town where the streets are lighted by electricity, the current is supplied by a private company, and the charges made by these companies cannot be taken as representing the cost of street lighting. For instance, in the city of London—where the public street lamps are supplied by a private company—there were about 11 miles of streets lighted by electricity at the close of last year. The street lamps supplied numbered 409, each with 2,000 nominal candle-power, or a total nominal candle-power of 818,000. The lamps superseded 1,126 gas lamps, of about 14 candle-power each, representing a total candle-power of 15,764. The amount paid by the Corporation for lighting these 11 miles of main streets is said to be £10,634 per annum, while the estimated cost during the same period of the gas lamps superseded is given at £3,720. With regard to St. Pancras, the committee learned that there the cost of electric lighting in the main streets was not likely to exceed the previous cost of gas. Finally, the committee say they have come to the conclusion that the lighting with arc lamps of the route from the "Angel" to Finsbury Park—namely, High Street, Upper Street, Holloway Road as far as the "Nag's Head," and thence along Seven Sisters Road to the park—which is projected as a commencement, would cost little, if any, more than the present cost of gas, particularly if arrangements are made for switching off half the lamps at midnight, or for fixing incandescent lamps to take the place of the whole of the arc lamps after that hour. Moreover, the illumination of the streets would be at least quadrupled.

Alleged Nuisance.—At the Greenwich Police Court last week the Crystal Palace District Electric Supply Company, Limited, were summoned by the Lewisham District Board of Works in consequence of a petition signed by ten inhabitants, for causing an effluvia to issue from their works at Springfield, Wells Road, Sydenham. It was stated that the persons who were affected thereby were mainly the residents in the Panmure Road, who occupied very good houses. Close by was a lawn tennis ground, and the secretary of the club which used that ground would tell them, as would other inhabitants, that the smell was sometimes so bad that play had to be discontinued and the players went away. In one instance, a gentleman who resided in Panmure Road, had to leave, as he could stand the smell no longer. So far back as July, 1893, the residents began to complain. The Board was appealed to, and at last it was suggested that if the complaint were formulated in the way provided by the Act, the Board would, of course, take the necessary proceedings to bring the matter before the Court. The managing director of the company (Mr. Geo. Offor) had in his possession in court a certificate signed by 167 residents in 22 roads and streets surrounding the works within an area of half-a-mile, stating that they had never experienced any nuisance from smoke or fumes produced by the works. We fail, however, to see how this certificate can have much weight with the magistrate, for the fact of 167 or more people not noticing the nuisance does not do away with the evidence of the ten who support the action, and who are residents in the Panmure Road, which is in very close proximity to the station. The case was adjourned, however, until October 9th, the company in the meantime to do everything in their power to abate the annoyance, and perhaps by then the parties will come to some mutual arrangement. We believe the company intend trying oil fuel to see whether that will remove the nuisance.

The Electro-Chemical Company, Limited. — The tenders for engines and dynamos for the first section of the company's plant, viz., 1,000 E.H.P., with water consumption guaranteed under a penalty of £1,000 per pound of water, were as follows:—

Parsons & Co, two steam turbines, 15½ lbs., 1,100 E.H.P.	£4,800
Yates & Thom, horizontal engines and Holmes's dynamos 15½ lbs. with extras, about	8,300
Willans & Robinson, four engines with Holmes's dynamos	9,700
" " " " Crompton's "	9,950
" " " " Siemens "	9,980
" " " " Mather & Platt's dynamos ...	10,100
Electric Construction Company, four Willans engines and E.C.C. dynamos, 17·384 lbs.	10,023
Easton & Anderson, 17¾ lbs. (with extras)	8,816
" " Willans engines ...	£10,850 to 11,140
Musgrave & Sons, engines only, 13½ lbs. per I.H.P. ...	6,224
Crompton's, four Willans engines, 17¼ lbs.	£10,780 to 11,140
Johnson & Phillips, dynamos only	2,675

The water consumption is under 160 lbs. per square inch, and includes steam used for feed and condenser pumps. Messrs. Parsons & Co.'s tender was recommended for acceptance by the consulting electrician (Mr. Swinburne), and has been accepted by the directors. Mr. T. Beeley, of Hyde, Manchester, has secured the contract for the boilers.

Price Lists, &c.—Messrs. Peto & Radford, of Hatton Garden, have sent us one of their latest revised price lists of pocket and portable accumulators, portable lamps, carriage and primary batteries, electric jewellery, dust-proof fittings, ammeters and voltmeters, battery cell testers, arc lamps and carbons, switchboards and main switches. The catalogue is nicely illustrated and details of prices are given of most of the articles dealt with. A number of testimonials are given at the end of the book.

Messrs. Fielding & Platt also have sent us a copy of their list of the Fielding gas engine (Otto principle). There are some large and fairly good illustrations.

Messrs. Johnson & Phillips have just published a new price list of arc lamps and accessories. There are some very good illustrations of the various styles of lamp, showing the internal and external views. The printing has been excellently executed on enamelled paper. Four pages out of the 24 are devoted to a list of some of the principal buyers or users of the Brockie-Pell arc lamp. Reference numbers are given for the articles and prices are clearly denoted. The last six pages deal with arc lamp accessories, including prices and particulars of round carbon rods.

Cheltenham Tenders.—The Town Council, last week, confirmed the following minutes of the Electric Light Committee:—"On the 24th ult. nine tenders for transformers were opened and handed to the electrician to examine and report. They were—The Brush Company, £394 15s.; Crompton & Co., £450; the Electric Construction Company, £455 10s.; Johnson & Phillips, £468; Slade, Templeton & Co., £500; Swinburne & Co., £522; C. A. Parsons and Co., £606 12s.; Siemens Bros. & Co., £677; Jno. Fowler & Co., £783 5s. On the 31st the electrician's report was considered, and the tender of the Brush Company was accepted."

Factory Lighting.—Messrs. Mardon, Son, and Hall, are having the electric light installed in their large new factory at Temple Gate, Bristol. The offices and works are being fitted with equal to 500 16-candle-power lamps. Arrangements have been made so as to allow of an addition of another 120 16-candle-power lamps if necessary. The current is supplied from an Edison-Hopkinson dynamo, by Messrs. Mather & Platt, and has an output of 350 ampères, with a pressure of 105 volts. The contract for the work has been secured by Messrs. F. W. Ball & Co.

Art Gallery Lighting.—Messrs. E. H. Berry & Pope have received the contract for the electric light fittings for the Art Gallery, Free Library, and Museum for the Blackburn Corporation, also for Nelson Technical School, and other club and hotel lighting contracts.

New Business.—Mr. Douglas C. Bate, Assoc.M.I.C.E., A.I.E.E., who has had a somewhat lengthy connection with electric lighting work, has recently commenced business on his own account at St. Martin's House, 1, Gresham Street, E.C., and 25, Market Place, Manchester. Among the contracts at present being carried out is the lighting of the Comedy Theatre, Manchester, and a large mill at Heywood.

According to a Lancashire newspaper, the works of Messrs. Milburn, Sons & Co., Limited, at Stalybridge, have been purchased by Messrs. Parker & White, of Manchester and London, who will at once re-start the concern as iron founders and electrical engineers. The new proprietors are said to be young, influential, and energetic gentlemen. The sale was effected for £6,000.

Mill Lighting.—Messrs. E. H. Berry & Pope, of Burnley, have received instructions for a complete electric light installation for the Monton Mills Company, Sabden, Lancs. This mill is being lighted throughout, including the weaving shed. Two dynamos will be used. Total number of lights to be installed is just over 400. They have also received instructions to instal about 150 lights at the Hob Lane Shed, Brierfield, near Burnley, for J. S. Vuners, Esq. The Shed is not being lighted, but the remainder of mill. The dynamos for the above have been manufactured by Rosling & Matthews, of Bradford.

Sunderland Exhibition, 1894.—We understand that Messrs. Ernest Scott & Mountain have obtained the contract for lighting the exhibition buildings with the electric light, including a searchlight for the tower. Demonstrations of electrical cooking will be made. To facilitate the exhibition of machinery, &c., in operation, shafting will be supplied with gas, water, steam and electrical power for exhibitors requiring such.

Electric Power for the Randt.—The Transvaal Government has approved of two schemes for supplying the Randt with electric power. One is to Messrs. Woodhouse & Rawson, who will bring power from the Vaal River, where the fall is 100 feet, and will generate 20,000 horse-power. The other is Messrs. Siemens & Halske, who will bring power from the Brakpan coal mines at a low cost.

The War in the East.—The steamship *Islam*, belonging to a Japanese firm, which has been seized on a warrant issued by the Foreign Secretary to the British Government, is being elaborately and carefully fitted up throughout with Baird, Thompson & Company's latest improved mechanical system of ship ventilation, which is capable of changing the whole atmosphere of the ship once every minute if necessary.

Broadstairs and St. Peter's Lighting.—The County of London and Brush Provincial Electric Lighting Company, Limited, have asked the Local Board to reconsider their decision to oppose the application that the company were about to make for a provisional order. The board have decided to take a neutral position in regard to the matter.

International Electric Subway Company.—At a meeting of the company held on 9th inst., at 39, Victoria Street, it was decided that as the company cannot, by reason of its liabilities, continue its business, it be wound up voluntarily, and Mr. C. W. Grimwade, of 32, Walbrook, was appointed liquidator.

Cooking by Electricity.—Last week the chairman of the Portsmouth Electric Light Committee (Alderman Ellis) gave a dinner to 25 friends and colleagues. The dinner was cooked entirely by electricity, the General Electric Company having loaned the necessary apparatus for the purpose.

Stowmarket Lighting.—A number of the tradesmen and others are clamouring after the electric light, and in meeting the other night they resolved to approach the lessors of the Gas Company with a view to inducing them to undertake the supply of electricity in the town.

Chapel Lighting.—Messrs. Bennett & Druce have been instructed to instal the electric light into the Saul Street Chapel, Preston, together with the adjoining vestries, schoolrooms, class rooms, &c. The current will be taken from the supply company's mains.

Perth and the Electric Light.—The Council have unanimously refused to consent to the application made by the Municipal Electric Light and Power Corporation, Limited, and the Caledonian Electric Supply Company, Limited, *re* provisional orders.

Huddersfield Electric Lighting.—An additional main is to be laid along Victoria Street. A sub-committee has been appointed to consider the desirability of reducing the rates, adopting a graduated scale and reducing the meter rents.

Electric Light at Wolverhampton.—Tenders amounting to about £2,000 are to be accepted by the Lighting Committee for lighting the Town Hall, Market Hall, School of Art, Art Gallery, and Free Library by electricity.

Carlisle and Electric Lighting. — The County of London and Brush Provincial Electric Lighting Company have notified the local authority of their intention to apply for a provisional order.

Colliery Electric Lighting.—The Acme and Immisch Electric Works, Limited, are installing a complete plant for the Victoria Coal and Coke Company, Limited, Wakefield, at their Park Hill Collieries.

Theatre Lighting.—The new Empire Palace Theatre, at Sheffield, will be lighted by electricity.

Wednesbury Lighting.—Alderman Williams the other day complained about the bad quality of the gas, and hoped the Gas Committee would go seriously into the question of electric lighting.

Sunderland Electric Lighting.—The corporation has resolved to charge 6d. per unit for current for lighting purposes, and 3½d. per unit for power purposes, these charges being subject to rebates.

Monmouth Electric Lighting Scheme.—The report of Messrs. Bramwell & Harris *re* the combined scheme for electric lighting and drainage, has been unanimously adopted by the Corporation.

Hampstead Electric Lighting.—The Electric Lighting Committee have been empowered to engage a staff for the central station, consisting of an assistant engineer and eight or nine labourers.

Dewsbury Electric Lighting.—The Local Government Board has sanctioned the borrowing of £2,150 by the guardians for the electric lighting of the workhouse premises and cottage homes.

Appointment.—Mr. E. G. Jones, late assistant engineer to the St. James's and Pall Mall Electric Light Company, has been appointed electrical engineer to the Corporation of Cape Town.

Hants County Buildings and Electric Lighting.—The Hants County Council have decided to light the county buildings by electricity. The estimated cost of the fittings is £325.

New Book.—Before leaving England Mr. Gisbert Kapp handed the final proofs of the fourth edition of his work on the "Electric Transmission of Power," to Messrs. Whittaker.

Electric Lighting at Lancaster.—The scheme of Mr. Barnard (the borough electrical engineer) has been adopted for the electric lighting of the Palatine Hall.

Electric Light at Leeds.—The Jewish Synagogue in Belgrave Street has been fitted with an electric lighting installation by Mr. T. Harding Churton.

Arbroath Lighting.—The Gas Corporation has resolved to oppose the Northern Electric Supply Company's application for a provisional order.

Electric Lighting of Public Offices.—The new offices of the Thames Conservancy on the Victoria Embankment are lighted by electricity.

Margate and Electric Lighting.—Two companies have given notice of their intended applications to Parliament for provisional orders.

Taunton Electric Lighting.—The electric lighting station, machinery, and plant have been insured for £6,000 at 4s. per cent.

Blackburn Electric Lighting.—The Corporation hope to be able to supply current in certain streets within two months.

Ayr Electric Lighting.—The situation of the electric lighting station will be at the Burgh Stores, South Harbour Street.

CONTRACTS OPEN AND CLOSED.

OPEN.

Dundee.—August 30th. For the following proposed contract in connection with the supply of electric light to the city of Dundee, under provisional order, for the Dundee Gas Commissioners—viz., contract No. 8, steam-engine and dynamo machine. Particulars to be obtained from Messrs. Urquhart & Small, 17, Victoria Street, S.W.

Spain.—Tenders are at present being invited by the Castro-Alen Mining Railway Company for the construction of a telephone line, 18 kilometres long, along its railway.

CLOSED.

Bath Factory Lighting.—Messrs. Alex. McTavish and Co., have secured the contract for the electric lighting of Messrs. Charles Bayer & Co.'s new stay factory, Oldlands Common, near Bitton. The plant consists of engine, boiler, dynamo, and wiring for 120 16-C.P. lamps.

Bootle.—The tender of Messrs. W. & J. Robinson & Co., for the necessary work and fittings required in connection with the lighting of Bootle Town Hall tower clock by electricity, for the sum of £195 has been accepted, subject to the terms of the existing contract.

Hull.—The Electric Lighting Committee of the Hull Corporation last Monday accepted the tenders of Messrs. Willans and Robinson for a new engine, for £1,247; and Messrs. Holmes, of Newcastle, for a dynamo, for £1,250, these being required to meet the increasing demands for the light in the town.

Southampton.—Messrs. Crompton & Co.'s tender has been selected from 25 others and accepted for carrying out the electric works at the Town Quay for £789.

Sunderland.—Messrs. Blakeborough & Son (of Brighouse) have secured the order for boxes and connections for street lighting, theirs being the lowest offer.

CITY NOTES.

Thomas Parker, Limited.

The first statutory meeting of Thomas Parker, Limited, was held last Friday at Wolverhampton.

Mr. T. C. Mander presided, and after the usual formal business had been transacted, in response to a shareholder who enquired how matters stood with the Electric Construction Company in respect to the Eickemeyer dynamo winding patents, stated that the purchase of the patents had been completed, that the legal proceedings commenced by the Electric Construction Company remained as they were, but that the directors were considering the question of granting a license to the company mentioned for the use of their patents on terms to be agreed. The chairman announced that the erection of the works was rapidly approaching completion, and that there was every prospect of the company at once entering upon a large and remunerative business.

Cuba Submarine Telegraph Company, Limited.

The report of the directors for the half-year ending June 30th, 1894, presented at the forty-sixth ordinary general meeting of shareholders, held on Wednesday, 22nd inst., reads as follows:—From the accounts it will be seen that the gross receipts amount to £24,703 9s., and the gross expenditure to £5,133 8s. 1d., leaving a sum of £19,570 0s. 11d., which, added to the balance brought from the last account, £2,259 5s., leaves £21,829 5s. 11d. at the credit of revenue account. Of this, the sum of £1,000 has been set aside as a further reserve against any loss from the deposits with banks. In view of the reserve fund having shortly to bear the cost of the new cable referred to below, the sum of £8,000 has been added to it, making the fund £113,000. The dividend on the preference shares will absorb £3,000, and leave £9,829 5s. 11d., out of which the directors recommend the payment of a dividend on the ordinary shares at the rate of 8 per cent. per annum, free of income tax, the balance, £3,429 5s. 11d., being carried forward to the current half-year. The cables have continued in good order throughout the half-year. A contract has been entered into with Hooper's Telegraph and India-Rubber Works, Limited, for the manufacture and laying of a new cable between Batabano and Cienfuegos, to replace the original 1870 one, which, as mentioned in last report, gave out at the end of the year. This cable will be laid in the beginning of next year, and its cost charged to the reserve fund. The company's suit against the Spanish Government at Madrid has made progress, but no decision has been given. The director who retires from the board at this time is Mr. Alexander F. Low, who, being eligible, offers himself for re-election. Mr. John Gane, the auditor, also retires, and offers himself for re-election. Annexed hereto is a comparative statement of traffic.

Mr. T. Greenwood presided at the meeting, and said the directors were pleased to be able to present so favourable a report. The expenditure and receipts were nearly the same as in the corresponding period of last year. Fortunately, they had had no repairs during the past half-year, so that that was the second period they had passed without repairs, while they had had payments in the previous year of £1,647 for repairs. They had also added £1,000 to reserve, as compared with £1,500 last year, against losses by deposits with banks, the result being that they were able to increase the amount carried forward to the reserve fund by £2,500, and also to improve their balance carried forward to the next half-year. That, he was sure, would be highly satisfactory to the shareholders, and they would have no difficulty in approving of the report and accounts submitted.

Mr. C. W. Parish seconded the motion, which was carried unanimously, without discussion.

London Platino-Brazilian Telegraph Company, Limited.—The half-yearly coupons, due on September 1st next, of the £100,000 6 per cent. debentures, will be paid on and after that date by Messrs. Glyn, Mills, Currie & Co., Lombard Street, E.C.

The Brush Electrical Engineering Company, Limited.—The transfer books of the 4½ per cent. debenture stock of the Brush Electrical Engineering Company, Limited, will be closed from August 25th to September 3rd inclusive.

TRAFFIC RECEIPTS.

The City and South London Railway Company. The receipts for the week ending August 19th, 1894, amounted to £861; week ending August 20th, 1893, £862; decrease, £1; total receipts for half-year, 1894, £6,064; corresponding period, 1893, £5,928; increase, £136.

The Western and Brazilian Telegraph Company, Limited. The receipts for the week ending August 17th, after deducing 17 per cent. of the gross receipts payable to the London Platino-Brazilian Telegraph Company, Limited, were £2,106.

SHARE LIST OF ELECTRICAL COMPANIES.

TELEGRAPH AND TELEPHONE COMPANIES.

Present issue.	NAME.	Stock or Share. ‡	Dividends for the last three years. 1891.	1892.	1893.	Closing Quotation, August 15th.	Closing Quotation, August 22nd.	Business done during week ended August 22nd, 1894. Highest.	Lowest.
184,500£	African Direct Teleg., Ltd., 4 % Deb.	100	...	...	...	101 —104	101 —104	...	...
1,134,640£	Anglo-American Teleg., Ltd.	Stock	£2 12s.	£2 15s.	£2 11s.	38 — 41	40 — 43	42	41½
2,932,680£	Do. do. 6 % Pref.	Stock	£5 5s.	£5 10s.	£5 2s.	74 — 76	76 — 78	77⅜	75¼
2,932,680£	Do. do. Defd.	Stock	...	...	...	6½ — 7	6⅞ — 7¼	7⅛	7
130,000	Brazilian Submarine Teleg., Ltd.	10	8 % §	6¼ % §	6¼ % §	12½ — 13	12½ — 13	12⅛	12⅛
75,000£	Do. do. 5 %, repayable June 1906	100	...	...	...	107 —111	107 —111	...	...
44,000	Chili Telep., Ltd., Nos. 1 to 40,000	5	... §	10 % ‖ §	... §	1 — 2	1 — 2	...	...
10,000,000$	Commercial Cable Co.	$100	7 %	7 %	7 %	139 —143	139 —143	...	...
224,850	Consolidated Telep. Const. and Main., Ltd.	10/-	3¼ % §	2 % §	2 % §	⅛ — ¼	⅛ — ¼	...	...
16,000	Cuba Teleg., Ltd.	10	8 %	8 %	8 %	12½ — 13½	12½ — 13½	13⅛	...
6,000	Do. 10 % Pref.	10	10 %	10 %	10 %	19½ — 20½	19½ — 20½	...	...
12,931	Direct Spanish Teleg., Ltd., £4 paid	5	4½ %	4 %	4 %	4 — 4½	4 — 4½	4½	4¼
6,000	Do. do. 10 % Pref.	5	10 %	10 %	10 %	9¼ — 9¾	9¼ — 9¾	...	...
30,000£	Do. do. 4½ % Debs of £50, Nos. 1 to 1,600	...	...	...	...	103 —106%	103 —106%	...	...
60,710	Direct United States Cable, Ltd., 1877	20	3½ % §	3½ % §	...	8 — 9	8¼ — 9½	...	...
400,000	Eastern Teleg., Ltd., Nos. 1 to 400,000	10	6½ % §	6½ % §	...	15⅝ — 15⅞	15⅝ — 15⅞	15 13/16	15⅝
70,000	Do. 6 % Pref.	10	6 % §	6 % §	...	16¼ — 16¾	16½ — 17	17	16¾
105,900£	Do. 5 % Debs., repay. August, 1899	100	...	...	...	105 —109	105 —109	...	...
1,294,100£	Do. 4 % Mort. Deb.	Stock	...	...	...	116 —119	117 —120	118½	116
250,000	Eastern Extension, Australasia and China Teleg., Ltd. ...	10	7 %	7 %	7 %	15⅝ — 15⅞	15⅝ — 15⅞	15⅞	15¾
62,700£	Do. 5 % (Aus. Gov. Sub.), Deb., 1900, red. ann. drgs. reg. 1 to 1,049, 3,976 to 4,326	100	...	...	...	103 —106	103 —106	...	...
222,800£	Do. do. Bearer, 1,050—3,975 and 4,327—6,400	100	...	...	...	103 —106	103 —106	...	...
320,000£	Do. 4 % Deb. Stock	Stock	...	...	...	114 —117	115 —118	...	...
95,100£	Eastern and South African Teleg., Ltd., 5 % Mort. Deb. 1900 redeem. ann. drgs., Reg. Nos. 1 to 2,343	100	...	...	...	103 —106	103 —106	101½	...
129,100£	Do. do. do. to bearer, 2,344 to 5,500	...	...	...	...	103 —106	103 —106	...	...
300,000£	Do. 4 % Mort. Debs. Nos. 1 to 2,016, red. 1909	100	...	...	...	103 —106	103 —106	101¾	103
200,000£	Do. 4 % Reg. Mt. Debs. (Mauritius Sub.) 1 to 8,000	25	...	...	...	107 —110%	108 —111%	...	...
180,227	Globe Telegraph and Trust, Ltd.	10	5⅛ % §	4⅞ % §	4⅝ % §	8½ — 8¾ xd	8⅝ — 8⅞ xd	8 15/16	8⅝
180,042	Do. do. 6 % Pref.	10	6 % §	6 % §	6 % §	15½ — 15¾ xd	15½ — 16 xd	16	15⅝
150,000	Great Northern Teleg. Company of Copenhagen	10	8¾ % §	8¾ % §	8¾ % §	20 — 21	20 — 21	...	...
200,000£	Do. do. do. 5 % Debs.	100	...	...	...	105 —108	105 —108	...	...
17,000	Indo-European Teleg., Ltd.	25	10 %	10 %	10 %	45 — 47	45 — 47	46½	...
37,548	London Platino-Brazilian Teleg., Ltd.	10	...	...	...	5 — 7	5 — 7	...	...
100,000£	Do. do. 6 % Debs.	100	...	...	...	108 —111	108 —111	...	...
15,000	Monte Video Teleph. Co., Ord., 1 to 15,000	5	...	...	...	½ — 1½	½ — 1⅝	...	...
28,000	Do. do. 6 % Pref., 1 to 28,000	5	...	...	...	1 — 2	¼ — 1½	...	...
484,597	National Teleph., Ltd., 1 to 438,984	5	6 % §	5 % §	...	4⅞ — 5⅛	4⅞ — 5⅛	5⅛	4 15/16
15,000	Do. 6 % Cum. 1st Pref.	10	...	...	...	14 — 15	14 — 15	...	...
15,000	Do. 6 % Cum. 2nd Pref.	10	...	...	...	13½ — 14½	13½ — 14½	...	...
119,234	Do. 5 % Non-cum. 3rd Pref., 1 to 90,950	5	...	...	...	5½ — 5⅞	5½ — 5⅝	5⅞	5⅝
925,017£	Do. 4½ % Deb. Stock Prov. Certs. ...	...	...	...	...	109 —112	108 —111	108½	...
48,800	New Teleph., Ltd., 25,901 to 74,700; £4 paid	10	...	...	...	... ...	... ...	...	...
171,504	Oriental Teleph. & Elec., Ltd., Nos. 1 to 171,504, fully paid	1	...	...	...	⅛ — ⅜	⅛ — ⅜	...	...
100,000£	Pacific and European Tel., Ltd., 4 % Guar. Debs, 1 to 1,000	100	...	...	...	102 —105	102 —105	103	...
11,839	Reuter's Ltd.	8	5 %	5 %	...	3 — 5	3 — 5	...	...
3,381	Submarine Cables Trust	Cert.	...	...	...	108 —113	108 —113	...	...
58,000	United River Plate Teleph., Ltd.	5	...	...	...	1 — 2	1 — 2	1¼	...
146,370£	Do. do. 5 % Debs.	Stock	...	...	...	85 — 95	85 — 95	...	...
15,609	West African Teleg., Ltd., 7,501 to 23,109	10	4 %	..	...	3 — 5	3 — 5	...	...
249,900£	Do. do. do. 5 % Debs.	100	...	...	...	102 —105	102 —105	...	...
30,000	West Coast of America Teleg., Ltd.	10	...	...	...	2½ — 3	2½ — 3	...	...
150,000£	Do. do. do. 8 % Debs., repay. 1902	100	...	...	...	96 —101	99 —104	100½	...
64,242	Western and Brazilian Teleg., Ltd.	15	4 %	2½ %	5 %	6⅞ — 7¼	6⅞ — 7¼	7 7/16	7 1/16
33,129	Do. do. do. 5 % Cum. Pref. ...	7½	...	...	...	5⅞ — 6¼	5⅞ — 6¼	6⅛	...
33,129	Do. do. do. 5 % Def.	7½	3 %	...	...	1¾ — 2¼	1¾ — 2¼	...	...
178,200£	Do. do. do. 6 % Debs. "A," 1910 ...	100	...	...	...	105 —108	105 —108	...	...
222,700£	Do. 6 % Mort. Debs., series "B," red. Feb. 1910	100	...	...	...	105 —108	105 —108	...	...
88,321	West India and Panama Teleg., Ltd.	10	¼ %	¼ %	⅜ %	1 — 1⅛	1 — 1⅛	...	...
34,563	Do. do. do. 6 % 1st Pref. ...	10	...	...	...	10½ — 10⅞	10¼ — 10⅞	10⅝	10½
4,669	Do. do. do. 6 % 2nd Pref. ...	10	...	...	..	9 — 10	9 — 10	...	...
80,000£	Do. do. 5 % Debs. (1917) No. 1 to 1,000	100	...	...	...	107 —110	107 —110	...	...
$1,214,000	Western Union of U. S. Teleg., 7 % 1st Mort. Bonds ...	$1000	...	...	...	115 —120	115 —120	...	...
169,000£	Do. do. 6 % Ster. Bonds.	100	...	...	...	100 —104	100 —104	...	...

ELECTRICITY SUPPLY COMPANIES.

20,510	Charing Cross and Strand Electy. Supply, 1 to 6, 215 to 718, and 10,001 to 30,000	5	...	5 %	4¼ %	4¼ — 5⅛	4¼ — 5⅛ xd	...	...
40,000	City of London Elec. Lightg. Co., Ltd., Ord. 40,001—80,000	10	...	...	...	12½ — 13½	12½ — 13½	13	...
40,000	Do. do. 6 % Cum. Pref., 1 to 40,000	10	...	6 %	6 %	14 — 14½	14 — 14½	14½	14 1/16
100,000	Do. 5 % Deb. Stock, Scrip. (iss. at £115) all paid	...	...	...	...	128 —131	128 —131	...	...
45,000	†Liverpool Electric Supply, £4 10s. paid	5	4½ %	5 %	5 %	6½ — 6⅝	6⅝ — 6⅞	...	...
49,900	*Metropolitan Electric Supply, Ltd., 6,101 to 50,000 ...	10	1 %	2 %	2½ %	8⅛ — 8⅞	8¼ — 8⅝	8⅝	8⅝
100,000£	Do. 5% Deb., 1 to 10,000 in bonds of £10, £20, £40	...	...	...	...	... — ...	... — ...	...	...
6,452	Notting Hill Electric Lightg. Co., Ltd.	10	...	...	...	4½ — 5¼	4½ — 5½	...	...
19,980	St. James's & Pall Mall Elec. Light Co., Ltd., Ord., 101-18,780	5	8½ %	7¼ %	4½ %	7 — 7½	6⅞ — 7¼	7⅛	...
20,000	Do. do. 7 % Pref., 20,081 to 40,080	5	7 %	7 %	7 %	8½ — 9	8¼ — 8⅝	...	..
59,900	*Westminster Electric Supply Corp., Ord., 101 to 60,000 ...	5	...	3½ %	4 %	6 — 6½	6 — 6½	6½	6⅜

* Subject to Founder's Shares. † Quotations on Liverpool Stock Exchange.

‡ Unless otherwise stated all shares are fully paid. ‖ Dividends paid in deferred share warrants, profits being used as capital

Dividends marked § are for a year consisting of the latter part of one year and the first part of the next.

SHARE LIST OF ELECTRICAL COMPANIES—*Continued.*

ELECTRICAL RAILWAY, MANUFACTURING, AND INDUSTRIAL, COMPANIES.

Present Issue.	NAME.	Stock or Share. ‡	Dividends for the last three years. 1891.	1892.	1893.	Closing Quotation, August 15th.	Closing Quotation, August 22nd.	Business done during week ended August 22nd, 1894. Highest.	Lowest.
90,000	Brush Elecl. Enging. Co., Ord., 1 to 90,000	3	...	6 % §	6 % §	2⅞ — 3	2⅞ — 3	2 15/16	2⅞
90,000	Do. do. Non-cum. 6 % Pref., 1 to 90,000	2	...	6 % §	6 % §	2¼ — 2½	2¼ — 2½	2⅝	2 5/16
125,000£	Do. do. 4½ % Deb.	Stock	...	...	...	110 —113	110 —113	...	...
630,000£	City and South London Railway	Stock	...	⅝%	⅝%	36 — 38	36 — 38 xd	37	36½
28,180	Crompton & Co., Ltd., 7 % Cum. Pref. Shares, 1 to 28,180	5	7 % §	7 % §	7 % §	2 — 2½xd	1⅞ — 2¼xd	2	...
50,000£	Do. do. 5 % 1st Mort. Debs., 1—400 of £100, and "A" 1—200 of £50 each	...	...	...	...	95 —100	95 —100	...	...
120,000	Electric Construction, Ltd., 1 to 120,000	2	...	...	...	½ — ¾	½ — ¾	...	...
12,845	Do. do. 7 % Cum. Pref., 1 to 12,845 ...	2	...	...	...	1¼ — 1⅝	1¼ — 1⅝	...	...
100,000	Elmore's French Patent Cop. Deposg., Ltd, 1 to 66,750 ...	2	*nil*	*nil*	*nil*	¼ — ⅜	¼ — ⅜	...	...
91,195	Elmore's Patent Cop. Deposg., Ltd., 1 to 70,000	2	*nil* ¶	*nil*	*nil*	1 — 1¼	1 — 1¼	1¼	1¼
67,385	Elmore's Wire Mfg., Ltd., 1 to 67,385, issued at 1 pm. ...	2	*nil*	*nil*	*nil*	¾ — 1	¾ — 1	1	...
20,000	Fowler-Waring Cables, Nos. 301 to 20,300	5	*nil* §	*nil* §	*nil* §	½ — 1½	½ — 1½	...	...
9,600£	Greenwood & Batley, Ltd., 7 % Cum. Pref., 1 to 9,600 ...	10	7 %	...	...	6½ — 7½	6½ — 7½	...	...
6,837	Henley's (W. T.) Telegraph Works, Ltd, Ord.	10	5 %	5 %	5 %	7 — 8	7 — 8	...	...
50,000	India-Rubber, Gutta Percha and Teleg. Works, Ltd. ...	10	12½%	12½%	12½%	23 — 24	23 — 24	23¾	23½
200,000	Do. do. do. 4½ % Deb., 1896	100	...	...	...	103 —105	103 —105	...	...
37,500	†Liverpool Overhead Railway, Ord.	10	...	...	1 %	8 1/16— 8 5/16xd	7 15/16— 7 15/16xd	...	...
6,295	† Do. do. Pref., £8 paid	10	...	...	...	12¾ — 13 xd	12¾ — 13 xd	...	...
78,949	Swan United Electric Light, Ltd., £3½ paid	5	11 % §	10 % §	7½% §	... — ...	... — ...	...	...
37,350	Telegraph Constn. and Maintce., Ltd.	12	20 %	15 %	20 %	40 — 42	40 — 42	41½	41⅜
150,000£	Do. do. do. 5 % Bonds, red. 1894	100	...	...	...	102 —105	102—105	104½	...
54,000	Waterloo and City Railway, Nos. 1 to 54,000, £2 paid ...	10	...	...	...	2 — 2¼	2 — 2¼	...	...

† Quotations on Liverpool Stock Exchange. ‡ Unless otherwise stated all shares are fully paid. ¶ Last dividend paid was 50% for 1890.

Dividends marked § are for a year consisting of the latter part of one year and the first part of the next.

Crompton & Co.—The dividends paid on the ordinary shares (which have not a Stock Exchange quotation), are as follows: 1892—0%§; 1891—7%§; 1890—8%§.

LATEST PROCURABLE QUOTATIONS OF SECURITIES NOT OFFICIALLY QUOTED.

Birmingham Electric Supply Company, Ordinary of £5 (fully paid), 5¼—5⅜.

Electric Construction Corporation, 6 % Debentures, 87—92.

Electric and General Investment, shares of £5 (£1 paid), 1¾—2¼.

Electricity Supply Corporation, Ordinary of £5, 5—5¼.

House-to-House Company (£5 paid), 1—1½.

Do. do. 7 % Preference, of £5, 5¼—5½.

Do. do. 6 % Debentures of £100, 101—103.

Kensington and Knightsbridge Electric Lighting Company, Limited, Ordinary Shares £5 (fully paid) 4⅜—5¼; 1st Preference Cumulative 6 %, £5 (fully paid), 6½—6⅞.

Liverpool Electric Supply, £5 (fully paid), 6⅜—6½.

Do. do. £3 10s. paid, 4½—4⅝.

London Electric Supply Corporation, £5 Ordinary, ⅝—1¼.

Queen Anne's Mansions Lighting and Heating Company, 6 % £100 Debentures, 101—103.

Yorkshire House-to-House Electricity Company, £5 Ordinary Shares (£4 10s. paid), 4¼—4⅜.

Bank rate of discount, 2 per cent. (February 22nd, 1894).

NEW PATENTS—1894.

15,034. "Improvements in instruments for measuring electric currents." W. Thomson (Baron Kelvin). Dated August 7th.

15,051. "An improved grip to be employed in laying electric cables." R. Middlemass. Dated August 7th.

15,065. "Apparatus for making electrical contact by passage of a railway train." E. Tyer. Dated August 7th.

15,070. "Improvements in overhead conductors for electric railways and tramways." W. J. Brewer. Dated August 7th.

15,072. "A system of submarine signalling." L. J. Blake. Dated August 7th. (*Complete.*)

15,082. "Improvements in magneto-electric machines for cycles or other vehicles and driving-gear for the same." E. Tilmann and C. K. Lexow. Dated August 7th. (*Complete.*)

15,095. "An improved composition and the production therefrom of blocks, slabs, vessels, or like articles, more especially intended for the production of paving blocks or slabs or conduits for electric cables." C. Jost. Dated August 7th.

15,129. "An improved process for evacuating incandescent lamp bulbs." A. Malignani. Dated August 8th.

15,170. "Improvements connected with arc lamps." J. J. Rathbone and A. Chester. Dated August 8th.

15,174. "An electrical rolling contact making and breaking device." K. Ast. Dated August 8th. (*Complete.*)

15,200. "Improvements in the utilisation of the waste products of gas and the like engines." G. Bell and G. W. Bell. Dated August 9th.

15,219. "Improvements in the method of and means for preventing undue reciprocal influences between telephonic lines, or between telephonic and telegraphic or other electrical lines." E. Muller. Dated August 9th. (*Complete.*)

15,258. "An improved material for the manufacture of lamp, gas, electric light shades, and other fancy articles." H. O'Reilly. Dated August 10th.

15,276. "Improvements in or connected with diaphragms for electrolytic purposes." M. Kiliani, W. Rathenau, C. Suter and Elektrochemische Werke Gesellschaft mit Beschrankter Haftung. Dated August 10th. (*Complete.*)

15,282. "Improvements in or connected with ploughing by electricity." F. Brutschke and H. Schimpff. Dated August 10th.

15,294. "Improvements in fuel economisers or feed-water heaters." J. G. Calvert. Dated August 10th.

15,312. "Improvements in gas engines and oil engines, the lubricating and governing of same." J. F. Bennett and F. H. Stacey. Dated August 11th.

15,316. "Improvements in gas and oil engines, and governing of same." J. F. Bennett and F. H. Stacey. Dated August 11th.

15,321. "Improvements in and relating to flexible telephone cords." O. Schrimpff and R. Riffelmacher. Dated August 11th. (*Complete.*)

15,353. "Improvements relating to electric motors." W. Routledge. Dated August 11th.

15,356. "Improved means for opening or closing valves, taps, electric switches, and the like." D. T. Bostel. Dated August 11th.

15,360. "Improvements in arc lamps." J. W. Rogers. Dated August 11th.

ABSTRACTS OF PUBLISHED SPECIFICATIONS, 1893.

10,772. "Improvements in ceiling roses and similar appliances for electric connections." G. H. Cutting. Dated June 1st. Claims:—1. The application to the base plate of an electrical ceiling rose, cut-out and the like of a disc of insulating material provided with metallic lugs or parts for electrical connection with the terminals and provided with safety fuse or fuses, the said disc being instantaneously detachable and attachable for the purpose of high insulation, easy wiring, replacing of a fuse, and other repairs. 2. The construction of electrical ceiling rose with detachable disc as shown and described. 3. The construction of electrical cut-out as shown and described.

12,785. "Improvements in switches for electric currents." A. G. New and A. J. Mayne. Dated June 29th. Claims:—1. A switch adapted for quickly making and breaking a circuit provided with springs, one of which is adapted to be stretched before any movement of the switch takes place and catches, one of which is adapted to be released by one of the parts which operate the springs, substantially as described. 2. The improved arrangement and construction of parts for quickly operating a switch for electric circuits, substantially as described and illustrated.